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New Holland-America Royal Mail Liner Rotterdam

The construction of this fine, large twin-screw steamer by Messrs. Harland & Wolff, Belfast, for the Holland-America Line's service between Rotterdam and New York reached its consummation on Wednesday, June 3, when the huge liner, which is by far the biggest ship of the year, left the quay and proceeded down Belfast Lough for adjustment of compasses and trial trip, prior to leaving for Rotterdam via Southampton.

Owing to her large size the Rotterdam, like the two large vessels built by Harland & Wolff last year, the President Lincoln and President Grant, could not be drydocked in Belfast. This important work, however, in connection with a Belfast-built steamer presents little difficulty now through the association of Belfast with Southampton since Messrs. Harlan & Wolff opened works at the southern port, where, as is well known, the docking facilities are exceptionally good. On the way round to Rotterdam, therefore, the vessel will call at Southampton, where Messrs. Harlan & Wolff will drydock and complete her with little delay, thanks to the convenient situation of that port geographically and also the convenient position of their docks in the Southampton docks. It will thus be seen that, as was anticipated at the time, Messrs. Harland & Wolff's establishment of a branch at Southampton was not only a most important development for them, but also a distinct advantage to Belfast, which is thus associated with one of the most progressive ports in the Kingdom through their instrumentality.

The Rotterdam, besides being one of the largest, is by common consent one of the handsomest vessels ever built. Like the other vessels of the line, she has been constructed to the highest class of Lloyds under special survey and to meet all the requirements of the British Board of Trade and the American law for passenger vessels, and the new vessel in every respect, in design, construction and decoration, represents the highest excellence yet attained in naval architecture. The enterprise, judgment and foresight of the owners, in conjunction with the ripe experience and practical knowledge of the builders, have left nothing undone to ensure the vessel being not only a work of art but an embodiment of every element that mechanical skill and ingenuity can devise to enhance the pleasure and secure the safety of ocean travelers.

The Rotterdam is nearly 25,000 tons gross register, with a displacement of over 35,000. She is an exceptionally strong structure, having nine steel decks and being built on the cellular double bottom principle, the double bottom extending the whole length of the ship, the depth of the inner vertical keel being 4 ft. 9 in. throughout, excepting under the engines, where it is increased to 5 ft. 7 in., the object of this being to give still greater rigidity in the vicinity of the machinery. The vessel has 12 watertight bulkheads, being thus divided into 13 watertight compartments. There is also a center line bulkhead in the cargo holds and between decks. The double bottom of course in addition to being an element of strength and security, provides space for water ballast, which is also carried in the fore and aft peaks and in deep tanks forward. The arrangements for cargo are of the most approved kind; there are seven cargo holds with hatches suitable for working grain elevators, and the bunkers are arranged so that the vessel can be completely coaled from either side. The vessel has two masts and two funnels. The cargo derricks are of the latest tubular type. The steam winches, windlass, capstans, boat davits, and other appliances for working ship and cargo, are also of the latest pattern.

The Rotterdam is fitted with a large refrigerating installation for both cargo and provisions, which also allows a complete system of cold storage in all the pantries for wine, cold dishes, etc., and iced water is led to different positions throughout the entire vessel.

The electric power and light machinery is also of large capacity, there being an electric elevator, electric service lift, also an electric hoist for stores, in addition to the electric fires and heaters, bells, fans, cooking apparatus, etc., and the enormous number of lights, something approaching nearly 5,000 throughout the ship.

There are two patent fire extinguishing machines, one forward and one aft, with a complete system of piping leading to every part of the ves-

sel, thus ensuring practical immunity from fire.

The steering engines and gear is of Harland & Wolff's latest type, controlled from the captain's bridge by means of a telemotor. This well-known gear, with which by means of an ingenious arrangement of steel springs the shocks and strains on the rudder are minimized, has long been regarded as an important element of safety in a ship.

The propelling machinery consists of two sets of quadruple expansion engines, with eight double ended and two single ended boilers. The engines are arranged on the "balanced" principle, by the scientific development of which the builders have attained a high degree of perfection with reciprocating engines, both as to the efficiency of their motive power and the abolition of vibration in the ship.

The general disposition of the passenger accommodation leaves nothing to be desired, the arrangements for all classes being conceived with a view to ensuring the utmost comfort and enjoyment. Whether in the magnificent public rooms in the first class, including the handsome saloon, smoke room, library, palm court, etc., the cabines de luxe, or in the second class rooms or the third class accommodation, all have been designed on the same generous scale, with the one object of meeting the requirements of respective classes of passengers. A glance at the description which we give below of the main features of the decorations of the principal rooms will enable the reader to form some idea, though only a faint one, of the artistic character of the work and the luxurious surroundings to which those who have the good fortune to travel in the vessel may look forward, and a visitor to the ship is struck at once not only with the beauty and symmetry of the whole decorations and arrangements, but also with the spacious character of the rooms both as to area and height, the dining saloons being the full width of the ship, the first class saloon providing seating accommodation for nearly 500 passengers, and the second class saloon for 300. The height of the upper and lower smoke rooms is 10 ft. 6 in. each, so that the total height of the combined room is 21 ft. The social hall is 11 ft. 6 in. high, and the palm court—which is an entirely new feature in naval architecture—is also of exceptional height.

The total number of passengers and crew will be close on 4,000.

The arrangements in this ship for the benefit of the large number of passengers to be carried are most complete. The heating and ventilation will be as perfect as mechanical ingenuity can ensure; the galleys and pantries have been specially studied with a view to the rapid and efficient serving of meals, and the electric elevator serves six decks, conveying passengers from the first class entrance on the middle deck up to the palm court, stopping en route when required at the saloon entrance, two intermediate decks and the social hall.

As is usual in vessels of the Holland-America line, the Rotterdam has a children's saloon or nursery, and there is a fruit and flower room, with special lockers for preserving passengers' own fruit and flowers.

As already indicated, special attention has been paid to the decoration of the public rooms, entrances and state rooms in this steamer. In the first class saloon the walls are of paneled work, painted in gray, decorated with different reliefs in white and old gold, relieved by double sets of stained glass windows, framed in brass. The ceiling is paneled with Lincrusta Walton. There is a beautiful "well" over the center decorated in the same style. This in conjunction with the gilded brass decoration of the mahogany sideboards gives the room a very handsome appearance. The tables (which are of mahogany) are arranged on the popular restaurant principle. The revolving chairs are of artistic design and in harmony with the sumptuous character of the apartment.

The social hall is in dark mahogany paneling work, inlaid with silver gray, rose and palm wood. The pilasters have old gold capitals and are relieved with handsome carving, and the apartment is lit by sets of treble (stained glass) windows, an entirely new and original feature in this ship. A glass partition divides the social hall from the vestibule, an arrangement which adds to the attractiveness of this room and would much remind one of the Carlton Ritz hotels, London. There are two large book cases in this room, also a fine organ, and a feature of the room is a magnificent mantelpiece of blue Turquin marble, above which is a very rich Dutch tile representing "Old Rotterdam" in 1744. The ceiling is decorated with light painted panels of ornate design, very pleasing to the eye. The room is most luxuriously upholstered and contains a magnificent grand piano in the center. The lighting is by crystal lights from the ceiling, with gilt brackets, specially designed and of wonderful effect.

The library is in Italian walnut paneling, inlaid with silver gray walnut and palm wood. The ceiling is decorated with light painted panels, and has a handsome stained glass dome in the center. The effect of the decoration and furnishing of this room is classic and comfortable, and the fireplace, while harmonizing thoroughly with the style, gives the room a homely appearance. A separate room for typewriters is provided on the starboard side, which should be a great boon to passengers.

Palm court. This room calls for special notice as constituting a new feature in naval architecture. The arrangement of the various flower boxes along the walls, and the pedestal in the center with plants and flowers, has been conceived on the most approved horticultural principles, and in conjunction with the artistic style of floral and landscape decoration is most entrancing. The paneling is in creme lacquered, with old gold ornaments, the style of decoration being trellis work, ornamented with laurel branches and flowers. The panels are decorated with large tiles of delft ware representing garden and country scenes in olden times. There is an enormous dome surmounting this hall and grand staircase, ornamented with stained glass covers. The floor is laid with india rubber tiles, covered with Persian carpets. There are groups of wicker tables, chairs and sofas, spread about for those who wish to linger in this delightful retreat.

First class smoke room. The smoke room, being one of the most important apartments in a modern passenger steamer, has received special attention. It has been arranged generally on the principle so popular with trans-Atlantic passengers, viz., with upper and lower rooms, common to each other by a very handsome and elaborate oak staircase. One of the features in this room, as in the other first class public rooms of this vessel, is the arrangement of the windows in sets of three, instead of in pairs as usual, greatly adding to the attractiveness of the room. The whole is executed in Dutch renaissance in furred oak with palisander and pear wood, inlaid, Dutch tiles of ancient and modern masters being introduced in the panels, the warm variegations of color giving a really harmonious effect, at the same time forming an agreeable ensemble. At the head of the staircase a very large oil painting of old Rotterdam by a celebrated Dutch artist commands attention and will amply repay the devotion of the artistic mind.

Round the walls panels embodying various coats of arms will also provide pleasure to the aesthetic taste. The fireplace in the lower room has given opportunity for the display of the highest excellence of the decorative art. The rooms are surmounted by a beautiful glass dome, completing the handsome character of the apartment. Outside at the after end of the upper smoke room a verandah has been arranged, with a skylight overhead, providing facilities for friendly concourse in the open air but protected from the weather. It may safely be claimed that the accommodation arranged and provided for smokers surpasses anything afloat.

The cabines de luxe. On the upper promenade deck are magnificent apartments 9 ft. 6 in. high. There are four bed rooms and bath rooms. In two of the rooms the furniture is of maple wood with rosewood inlaid, and the other two mahogany with palm wood inlaid. Each room has luxurious brass bedsteads, combined wash stand and toilet wardrobes, and easy chairs. The two sitting rooms are in modern Louis XVI style, white lacquered, with silk panels, rich carpets and upholstery in appropriate colors. Servants' rooms are provided in conjunction with these cabines de luxe. There are also cabines de luxe on the lower promenade deck.

A special feature of the first class accommodation is the large number of one and two berth rooms, also suite rooms with private baths, these suite rooms being fitted with brass bedsteads. All upper berths in first class state rooms are Pullman berths which give a much more roomy and tidy appearance than the ordinary arrangement.

The promenade spaces on this vessel are exceptional, and on the upper promenade deck a new feature has been introduced by the company, viz., an arrangement of large frameless plate glass windows across the front and along the sides nearly the whole length of this deck, doing away with the old canvas screens, which had many disadvantages. At the same time the passengers have the great advantage of a covered-in promenading space without any interruption in their view of the horizon. The windows can be lowered and kept in any position by an ingenious arrangement of springs, making the deck an ideal promenade, which will doubtless be greatly appreciated by the passengers.

The decoration of the second class public rooms in this ship is also of a very high order. The second class saloon, library and smoke room, also the entrances, being exceptionally fine apartments. In the second class saloon the general scheme of the decoration is white relieved with gold. The library is paneled satinwood relieved with carving, and the smoke room is in Austrian wainscot oak, with dado and furniture of polished walnut. The public rooms and passages throughout the second class accommodation are laid with linoleum tiles, ensuring the quietness so much appreciated on board ship.

The comfort of the third class passengers is all that could be desired, the accommodation for them being excellent, the enclosed cabins being large and comfortable, and separate dining, smoking and general rooms being provided, also open and enclosed promenading spaces.

The vessel is fitted with the very latest and most improved Marconi system and has also for the safety of the ship and passengers a submarine signaling apparatus. In fact, the vessel when she leaves Rotterdam on her maiden voyage on June 13 will have no equal in many points both as regards construction, general design and completeness.

Mr. Wierdsma, the president director of the company, arrived from Rotterdam with a large party of friends and his son, Rypperda Wierdsma, who is also a director, joined the ship, having arrived at Queenstown by the Lusitania from New York. Mr. Van Holden, the engineer-in-chief of the company, and under whose direction and superintendence the ship was constructed and completed, also joined the vessel for her trial trip, and the ship left under the command of Captain F. H. Bonjer, the commodore captain of the Holland-America line, whose entire mail fleet, except the Potsdam, was built and completed in Ireland, the Rotterdam being the fourteenth vessel for this company first floated in the waters of the Lagan.

DECISION IN HAVERFORD EXPLOSION.

Judge Adams, in the admiralty branch of the United States district court, on June 8 dismissed the suit of the International Mercantile Marine Co. vs. Messrs. Joseph Fels and Samuel F. Fels, which grew out of the explosion on board the steamer Haverford, of one of the company's lines, June 14, 1906. The catastrophe occurred while the vessel was at her dock at Liverpool, Eng., and resulted in the loss of 13 lives and heavy damage to the steamer. After a long investigation the company decided that the explosion was caused by the inflammable vapor arising from a shipment of "naphtha soap," made by the defendants. Suit was begun on March 28, 1907, and $100,000 damages were asked. In the complaint it was charged that the defendants knew the character of the cargo to be dangerous, and should have stated that fact when they arranged for the consignment. The Messrs. Fels asserted that the accident was due to an infernal machine on board the vessel, and that their soap is not explosive unless confined in an air-tight place where there is no opportunity for the gases to escape. Their product had been shipped around the world for 20 years, they asserted, without a single accident having occurred. In his decision Judge Adams practically held that the explosion was caused by gas from the soap, but dismissed the action on the ground that the steamship company well knew the nature of the soap and had neglected to stow it where it would have proper ventilation and could be safely carried.

SEASICKNESS.

In the prize essay department of the *New York Medical Journal* of May 30 are papers by P. A. Surg. Charles S. Butler and Robert A. Bachmann, U. S. N., on the ever engrossing subject of seasickness and the proper treatment of it. Dr. Butler says there is no specific for the ailment, and that the thing to strive for is immunity, which is only relative after all, since the hardiest sailor is liable to succumb to an unusual stress of weather. He divides victims into three classes: those who have slight nausea that rapidly wears off; those having more persistent symptoms who ultimately acquire immunity, and those who never become used to the oscillation of the ship. Members of the last class are rare, he thinks. For those in the second class, by far the large majority, he recommends careful dieting and catharsis, and abstinence from alcohol, coffee, tea and tobacco before sailing. Sleep during the day on shipboard should be discouraged, interfering with the regular sleeping hours. Orientation is an important factor in obtaining immunity. The most distressing part of a ship's motion is the pitch, as the roll can be anticipated. The sailor learns to go with the ship in pitching, the landsman fights against it. Once the traveler has learned to be part of the ship instead of trying to right it, a big step toward immunity has been taken. He advises avoiding sources of depression, like tea,

coffee, alcohol and tobacco; keeping the secretions active; learning to be part of the ship; cultivating a good daily routine, staying on deck amidships as much as possible; refraining from sedatives, and maintaining cheerfulness. The thousands of wan travelers who have been tormented by friends and stewards to eat in the face of nausea on the never-say-die and fight-it-out theory will thank Dr. Bachmann for his caution against such procedure as "bereft of good reasoning." Hot applications to the head often relieve severe cases of retching. The three main considerations in his opinion are "a normal digestive tract, fresh air and the reclining position."

BRAZILIAN DRY DOCK.

Consul-General George E. Anderson writes, from Rio de Janeiro, that as a part of its new naval policy, which has taken the form of three of the largest battleships now building, the federal government in Brazil has made arrangements for the construction of the largest dry dock in South America, a description of which follows:

This dock is to be available for merchant vessels as well as war ships and is a most important step in maritime development in South America. The dock is to be secured by a reconstruction of the Mortona dock, owned by the government of Brazil and used until recently by the Lloyd Brazileiro for its merchant ships. The old dock is to be widened and deepened much along its present lines on the water front of Rio de Janeiro adjoining the new commercial wharves or docks. By the plans finally adopted 100,000 cubic meters of rock will be excavated from the bottom, sides and land end until the dock will have a total inside length great enough to admit a vessel 250 meters, or about 815 feet. It is to be divided into three sections—one 150 meters, one 70 meters, and the third 30 meters—so that three vessels of proper size can be handled at the same time.

The dock is to be fitted with all the latest appliances, both with respect to naval and merchant vessel needs. Inasmuch as it will afford necessary conveniences for the docking and repair of vessels up to 15,000 to 16,000 tons, it is a distinct advancement in South American shipping. The work on the dock will be under government auspices. It is to be commenced at once and will be completed in two years. The largest merchant vessel now making regular runs to this port is less than 12,000 gross tonnage, hence the dock is well ahead of commercial requirements.

TABLET TO LINCOLN.

The bronze memorial tablet to Abraham Lincoln, presented to the Hamburg-American line steamship President Lincoln by the Grand Army of the Republic, was unveiled on board the vessel, lying at her pier in Hoboken, N. J., on Friday last. The tablet, upon which is engraved Lincoln's Gettysburg address, was installed at the head of the main companionway of the upper promenade deck, where the guests were gathered. Charles Burrows, quartermaster general of the Grand Army of the Republic, spoke of the mission of the survivors of the war of forty-odd years ago, in leaving to coming generations such tablets as this as "an object lesson that shall cause the young of our land to read its history and learn to treasure their inheritance." Captain Hebbenghaus, naval attache of the German embassy at Washington, detailed by Emperor Wilhelm to represent the German empire at the installation, called attention to the good will and friendly feeling between the two nations, saying that such functions as this tended to bring the two nations still closer together. Lieut.-Commander W. S. Sims, detailed by President Roosevelt to represent the government, also referred to the closeness of the relations between the United States and Germany. Nicholas Murray Butler, president of Columbia College, spoke of the increasing good feeling between Germany and the United States, and Wrenn Lee Goss, national patriotic instructor of the Grand Army of the Republic, concluded the exercises with a short survey of Lincoln's character and his place in posterity.

LATE OPENING IN THE 60'S.

"Persons who have been saying that this is the latest opening of navigation we have ever experienced on the great lakes don't know what they are talking about," said Capt. M. Mulholland, commodore of the Bradley fleet. "I remember one season in the early '60's when I left this port for Escanaba in April on the little schooner H. G. Cleveland, and, although she only carried 470 tons, we didn't get away from Escanaba with our load until August. That was what I would call a mighty late start, and we only got 45 cents a ton for carrying down that ore. But we more than made up for it the following season, when we got $3 per ton for the Escanaba ore in October and November. I cleared up $6,500, with that little schooner that season, besides buying some new sails for her. She was owned by Edward & Townsend and Abe Welner, of Cleveland."

CITY OF MONTREAL WHEEL CHAINS PART.

The propeller City of Montreal of the Merchants line of Montreal went ashore last week in Talcott's bay, about three and one-half miles above Massena, on the American side of the St. Lawrence river. The vessel was on her way up the river and had reached a point opposite Richard's Landing, when her rudder chains broke. As she was in swift water it was feared she would be swept down the long Sault Rapids and there was a panic among the passengers.

An ineffectual attempt was made to dock the boat at Richard's Landing, and while the passengers were running about in a state of terror the big craft floated down stream until she finally brought up on the beach at Talcott's bay, a mile from Richard's Landing. Some of the passengers remained on the craft, others being taken ashore.

The City of Montreal is said to be leaking and tugs have been sent for. The vessel carried 40 passengers and 600 tons of freight. She is 206 ft. long and of 32 ft. beam and was built at Buffalo in 1871. She was formerly in the Anchor Line of Buffalo.

LAKE ERIE HARBOR IMPROVEMENTS.

The United States Lake Survey of Detroit gives the following report of conditions at Lake Erie harbors, in charge of Lieut. Col. John Millis, United States Engineer at Cleveland.

At Huron, O., the new east jetty has been completed, and 500 feet length of the old east pier is removed; the removal of the remainder, projecting about 450 feet north from the shore line, is in progress. The present piers are 300 feet apart at the outer ends, from which the east pier diverges at an angle to shore so as to form a gradually widening basin to eastward of the channel. This area inclosed by the piers will be deepened to 21 feet. Outside of the pierheads, in line with the channel, there is ample depths for all vessels.

On May 20 the U. S. dredge Burton completed the removal of shoals from the channel at Fairport Harbor, O., providing sufficient depth for navigation, and the dredge was next assigned to clear the channel at Conneaut, O.

SUMMARY OF NAVAL CONSTRUCTION.

Name of Vessel.	Building at—	—1908— Per cent of completion. May 1.	June 1.
BATTLESHIPS.			
South Carolina	Wm. Cramp & Sons	45.9	49 0
Michigan	New York S. B. Co	50.7	53.0
Delaware	Newport News S. B. Co	22.8	27.4
North Dakota	Fore River S. B. Co	31.6	35.7
ARMORED CRUISERS.			
Montana	Newport News S. B. Co	98.0	98.8
SCOUT CRUISERS.			
Salem	Fore River S. B. Co	96.4	97.1
TORPEDO BOAT DESTROYERS.			
T. B. Destroyer No. 17	Wm. Cramp & Sons	15.9	21.3
T. B. Destroyer No. 18	Wm. Cramp & Sons	15.4	19.7
T. B. Destroyer No. 19	New York S. B. Co	16.2	22.4
T. B. Destroyer No. 20	Bath Iron Works	9.7	11.5
T. B. Destroyer No. 21	Bath Iron Works	9.3	10.9
SUBMARINE TORPEDO BOATS.			
Submarine T. B. No. 9	Fore River S. B. Co	99.0	99.0
Submarine T. B. No. 13	Fore River S. B. Co	40.5	45.3
Submarine T. B. No. 14	Fore River S. B. Co	39.9	45.2
Submarine T. B. No. 15	Fore River S. B. Co	34.0	44.9
Submarine T. B. No. 16	Fore River S. B. Co	34.2	45.1
Submarine T. B. No. 17	Fore River S. B. Co	13.6	27.5
Submarine T. B. No. 18	Fore River S. B. Co	13.4	23.1
Submarine T. B. No. 19	Fore River S. B. Co	13.0	23.1
COLLIERS.			
Vestal	Navy Yard, New York	80.6	85.2
Prometheus	Navy Yard, Mare Island	52.3	59.3
TUG BOATS.			
Patapsco	Navy Yard, Portsmouth	63.0	70.0
Patuxent	Navy Yard, Norfolk	60.2	65.7

SHIP BUILDING DURING MAY.

The bureau of navigation reports 116 vessels of 51,401 gross tons were built in the United States and officially numbered during May, as follows:

	WOOD				STEEL				TOTAL	
	Sail		Steam		Sail		Steam			
	No.	Gross	No.	Gross	No.	Gross	No.	Gross	No.	Gross
Atlantic and Gulf	8	2,628	24	1,117	....	....	....	....	32	8,745
Porto Rico	1	33	....	....		....	....	....	1	33
Pacific	2	15	44	2,072	....	....	1	1,838	47	3,925
Hawaii	.	....	..	....	....	....	....	....	...	....
Great Lakes	....	....	10	436	....	....	8	42,105	18	42,541
Western Rivers	....	....	17	1,148	...	....	1	9	18	1,157
Total	11	2 676	95	4,773	..	......	10	43,952	116	51,401

The largest steel steam vessels included in these figures are the J. F. Durston, William H. Wolff, William Livingstone, John A. Donaldson, Adam E. Cornelius, W. R. Woodford, Howard M. Hanna Jr., and Honduras, all lake built.

CHECK AT DETROIT RIVER TUNNEL.

The following notice has just been sent out to all masters and pilots by William Livingstone, president of the Lake Carriers' association:

"Gentlemen—As you are aware, the railroads are engaged in constructing a tunnel in Detroit river near the Michigan Central railroad ferry slips. They complain that the work of the plant engaged in the tunnel construction is often seriously hindered by the speed of passing vessels, and this is especially the case when the tubes forming the sections of the tunnel are being lowered into place. Vessels should at all times run under check when passing this work, and also further reduce their speed when signaled to do so by three short blasts of a whistle on the contractor's plant.

"A request has been made by the United States engineer, Col. C. McD. Townsend, that our masters and pilots co-operate in protecting this work.

"The original intention of the contractors was to drive piles in the river during the construction of this work, but they now propose, unless seriously interfered with, to avoid doing so altogether, which will be a benefit to navigation."

DREDGING EQUIPMENT ON THE PANAMA CANAL.*

BY F. B. MALTBY.

The writer during a connection of about two and a half years with the Isthmian canal commission, most of which time was spent on the isthmus, had charge of the design, construction, maintenance and operation of the dredge plant employed, and it is proposed to give a brief description of this machinery.

There are in use or being built four distinct types of dredges of entirely different characteristics. First, the old French ladder dredges; second, American dipper dredges; third, sea-going suction dredges; fourth, pipe-line suction dredges.

The so-called old French ladder dredges are those which the Americans fell heir to when the canal property was purchased from the French canal company. There were some 16 or 17 of these dredges, of the endless bucket type. They vary somewhat in detail, but are all of the same general construction. The digging apparatus consists of an endless chain of buckets holding about 14½ cu. ft. each. This chain of buckets is carried by a box girder hinged at the top and of sufficient length to enable the dredge to work to a depth of about 30 ft. The buckets discharge into chutes leading over the side of the dredge and into barges alongside.

The chain of buckets is driven with a pair of steeple compound condensing engines, which are connected with the top tumbler wheel either through gearing or by friction wheels and large sprocket chains. Steam is supplied by Scotch marine boilers, working under a pressure of 70 to 80 lbs. The hulls are of genuine wrought iron, not steel, and some of them were supplied originally with propelling machinery, but this has been taken off. The hauling and hoisting winches are simple but cumberson and 1¼-in. chain is used for hoisting the ladder as well as for moving and maneuvering the dredge. No quarters were provided for the crews. These dredges were built either in Belgium or in Scotland. Some of them had been pretty well worn out and were of little value. Most of them were in a remarkably good state of preservation, although most of them had not been in use for at least 18 years. The woodwork was entirely rotted away and required renewing throughout. The machinery had been carefully laid up and was painted and had been well cared for.

*Abstracted from Proceedings of The Engineers' Club of Philadelphia for January, 1908.

It required only cleaning up. packing of joints and occasionally a rod needed truing up. The hulls, on account of being wrought iron, had corroded very little and were practically as good as new.

One of these old dredges was rebuilt at Cristobal and put into operation in May, 1905, and a second one was afterward rebuilt and repaired. The Panama Railroad Co. was operating one at the Pacific terminus and it was turned over to the canal commission in June, 1905, and a second and a third one have been rebuilt at that end.

These dredges of the non-propelling type have hulls of rectangular shape, about 114 ft. long, 32 ft. wide and 12 ft. deep. The engines operating the chain of buckets are of about 180 H. P. and are operating condensing. These dredges have no means for breaking up the material to be excavated other than the buckets themselves, and consequently their digging capacity or the ability to force the buckets into hard or compact material is not very great. For these reasons their capacity per day varies with the material to be excavated.

At La Boca, the Pacific terminus, there are two of these dredges in operation, working 24 hours per day and six days in the week. During the month of October, 1907, one of them removed 143,222 and the other one 143,885 cu. yds., an average of about 5,300 cu. yds. per day. The maximum daily output in November was 6,907 cu. yds. and 7,556 cu. yds., respectively. The material handled is mud with a very considerable portion of sand, very easily excavated and handled with this type of dredge. During October, 1907, one of this same type of dredges removed 133,064 cu. yds. from the new channel in Limon Bay, or the Atlantic terminus. The reduced output below that of the dredges on the Pacific side is due to a greater seaway on the Atlantic side and also to the fact that the mud encountered is softer, and while it is easier to excavate, it is so soft that it will not pile up in the buckets and more or less is lost during the passage of the buckets through the water. The capacity of these dredges excavating in coral rock is reduced by about one-half. The material excavated is taken out to sea and dumped into deep water, the length of haul varying from two to four miles.

The dredges are served by self-propelling hopper bottom dump barges, which are also a part of the old French equipment that has been rebuilt. These barges have a hopper capacity of about 225 cu. ft. long and are driven by twin screws and compound condensing engines. The hopper doors are operated by hand winches.

The operation of these old dredges has been rather surprising and very satisfactory. Their machinery, though cumbersome, is very simple, and very little trouble has been experienced through breakdowns. The buckets have cast steel backs with ¾ or ⅞ steel fronts and bottoms riveted to them. They have an extra cutting tip or edge of 1-in. steel. The eyes in the links and bucket backs forming the chain are bushed with steel and have steel pins. These bushings and pins wear very rapidly, but their renewal is a very simple and inexpensive matter.

The bearings for the lower tumbler wheel, which are constantly working in sand and grit, also wear very rapidly; the journal boxes are of cast steel and made solid and without any provision for taking up wear. They are usually allowed to run till the boxes are nearly or quite worn through on the bottom.

The cost of handling material with these dredges, including the cost of operation, superintendence, all running repairs and the cost of operating the barges, is between 9 and 10 cts. per cu. yd., though monthly costs have gone as low as 5 cts. per cu. yd. This cost does not include any proportion of first cost or depreciation or the first cost of extensive rebuilding.

It is evident that for excavating soft material to a moderate depth this type of dredge has certain advantages that are not appreciated in this country. They are very similar to the gold dredges that have been so extensively and successfully used throughout the west.

The second type of dredge in use is the dipper dredge. This is strictly an American type of dredge and was originated and has been used in this country to a greater extent than any other type in use. They can be briefly described as a steam shovel gone to sea, as they have all the characteristics of a steam shovel with the parts made usually much heavier and with a radius of action greater than a steam shovel. Three of this type of dredge have been built and are in operation on the canal, one on the Pacific side and two on the Atlantic side. Two of them were built by the Atlantic, Gulf & Pacific Dredge Co., after designs made by A. S. Robinson, and the other one by the Featherstone Foundry & Machine Co. All three are of the same size and general construction. Steel has been used throughout, except in the spuds and dipper handle, which are of wood, the latter lined with steel angles and plates.

They have steel hulls 110 ft. long, 37 ft. wide and 9½ ft. deep, and are proportioned to excavate to a depth of 40 ft. of water. They have dippers with a capacity of 5 cu. yds. for excavating in sand or mud and have extra dippers of 3 cu. yds. capacity and fitted with very heavy manganese steel teeth, to be used for continuous operation in rock.

The main engines operate the hoisting and backing drums and also the drums for handling the spuds, while the swinging is done with an independent engine. The are equipped with independent capstan engines and electric light plants. Steam is supplied by Scotch marine boilers at a working pressure of 150 lbs. The booms are of very heavy construction and about 52 ft. long and are carried directly on the turntable without any overhead gallows frames. The spuds are of Oregon fir, 60 ft. long. On two of the dredges these are single sticks 36 in. square, while on one of them the spuds are built up and are 42 in. square. The main hoisting lines are crucible steel cables leading direct to the dipper without the intervention of any purchase blocks, and all sheaves over which the line passes are 6 ft. in diameter. On two dredges two cables, each 1⅝ in. and laid side by side, are used, while on the other one a single cable 2¼ in. in diameter is used.

The engines, gearing and drums are proportioned to give a pull on the hoisting line of about 90,000 lbs. These dredges were built under general plans and specifications prepared by the writer, the details being left to the builders.

The principal advantage of this type of dredge lies in its ability to dig in hard material. It has been found quite possible to excavate coral rock without blasting, though the progress of the work is expedited by a small amount of shooting to loosen up the ledges and to permit the dipper to get a better hold on the rock. A somewhat smaller crew is required than on a ladder dredge, though the operator must be a much higher paid man, as the capacity of the machine in any given material depends almost entirely on the ability of the operator to keep it in constant and rapid operation.

Owing to some mechanical defects

the operation of these dredges has not been as entirely satisfactory as was hoped, though I understand that these have been remedied to a very large extent. They cost about $102,000 apiece delivered on the isthmus. During 20 days in the month of October, 1907, one of these dredges removed 70,000 cu. yds. from the channel at the Pacific terminus, while the maximum daily output in November was 4,456 cu. yds.

The third type of dredge, and possibly the most important, owing to their size and cost, in use on the canal is the sea-going suction dredge. Two of this type have been built, one for each terminus, and one of them has been in operation at Colon since September, 1907. The second one, the Culebra, reached La Boca under her own steam Dec. 28, 1907, after a voyage of about 12,000 miles, much of it through heavy weather.

These dredges are designed to operate in the harbor entrances to the canal and are therefore built self contained and are able to work in a considerable seaway. In general design they are very similar to the dredges Manhattan and Atlantic, in use in excavating the new American channel to New York harbor, and to the dredge Delaware, in use in the Delaware river. They differ from these dredges in the detail of their dredging machinery and also in their equipment and arrangement of quarters.

Their hulls are of steel, 274 ft. long between perpendiculars and 288 ft. long over all, with molded beam of 47½ ft. and depth of 25 ft. The hull framing is made in accordance with the rules of the American bureau of shipping for vessels of class A1. They have twin screws and are propelled by compound condensing engines 22 x 44 x 30 in. stroke.

The dredging machinery consists of two 20-in. single suction centrifugal pumps direct connected to compound condensing engines running at from 160 to 170 R. P. M., and at these speeds developing from 440 to 460 I. H. P.

The centrifugal pumps are located on each side of the ship a little aft of amidships. They have inclosed cast steel runners about 72 in. in diameter with six blades about 19 in. wide. The suction from each pump passes through the side of the ship a little below the loaded water line and is joined to the suction pipe through a swivel elbow. The suction pipe is 20¼ in. inside diameter, ⅜ in. thick, and the sections are joined together by forged steel flanges welded onto the pipe. These flanges and the welded point have a greater strength than the pipe itself. The suction pipe is about 63 ft. long over the suction shoe and the dredge can excavate to a depth of 40 ft. in water. The pumps discharge into sand bins having a nominal capacity of about 2,000 cu. yds. Steam is supplied by four Scotch marine boilers 14 ft. in diameter, 12 ft. long, under a working pressure of 150 lbs.

The dredges are equipped with the usual condensers, pumps, and auxiliary machinery, and in addition have electric lights, evaporators, and a complete ice-making and refrigerating plant.

The dredges are entirely self contained and are able to operate for a week or more with the coal and stores which they will carry.

Quarters are provided for a crew of about 57 men. The details of the dredging machinery, sand bins, and arrangement of quarters, etc., were designed by the writer, while the general construction follows that of the dredges previously mentioned. They were built by the Maryland Steel Co. at Sparrows Point, Md., and cost about $724,000 for the two.

The operation of the one now in commission has been most satisfactory, and there is every reason to believe that the second one will be equally as successful. On their tests they handled from 1,600 to 1,700 cu. yds. of sand and mud per hour.

The centrifugal sand pumps carried a vacuum on their suction side of from 26 to 28 in. Their nominal capacity is about 2,000 cu. yds. per hour in clean sand or sand with only a small proportion of mud.

The trip from Sparrows Point to Colon, a distance of 1,906 miles, was made in eight days and nine hours, including about half a day that she was hove-to on account of a storm, or an average of 9½ knots per hour.

The dredge is operated for 24 hours per day for 5½ days per week, Saturday afternoon being used for coaling and taking aboard stores.

During the month of September, with a green crew and new machinery, 266,000 cu. yds. measured in place was excavated in the harbor at Colon; in October 273,500 cu. yds. and in November 304,000 cu. yds.

The material is mud and does not readily settle in the bins, though it is very readily excavated. By actual measurement it has been found that the pumps have handled as high as 87 per cent of solid material. The length of haul to the dumping ground is two to three miles. In commenting on the work of the dredge during September the "Canal Record" estimated that the excavation and disposition of the same amount of material from Culebra cut would have required the work of 14 steam shovels, 30 locomotives and work trains, and about 1,500 men. The crew of the dredge consists of 57 men.

The fourth type of dredge to be used in the canal is the pipe line suction dredge, or a suction dredge which deposits on shore, through a pipe line, the excavated material. The French company had several small dredges of this type, used for rehandling material, but they were never very successful in operation on account of the design of the pumps.

These pumps had suction and discharge pipes 16 in. in diameter. The pump runner was about 24 in. in diameter and had blades about 4 in. in width. These proportions will perhaps be better appreciated by comparing them with a pump for the same sized discharge pipe which was put onto one of these dredges which had a runner 69 in. in diameter with blades 11 in. wide inside the shroud.

One of these small dredges was rebuilt and a pump of the size just mentioned put on it. The dredge has been used in filling material into the low ground adjacent to Colon and in opening a channel in the old canal between Cristobal and Gatun, portions of which had been filled up. The material from the channel was pumped ashore.

It is proposed to build the great Gatun dam by the hydraulic method or by pumping the material into place. The hydraulic method of dam construction is not new and has been extensively used in the west, but usually in localities where flowing water with a source at sufficient elevation is available for transporting the material. It should, however, make no difference in the success of construction of this nature whether the water is secured from mountains under a sufficient head to give the necesary velocity for transportation or this velocity is given by pumps. For this purpose two dredges are being built, which will first borrow as much material as can be had within reasonable distance of the dam, and will then rehandle and pump into the dam material excavated from the canal and brought to the site in dump barges.

These dredges are of steel, 135 ft. long by 36 ft. wide and 9 ft. deep. They have a single 20-in. pump with double suction driven by a pair of tan-

dem compound condensing engines developing about 450 I. H. P. The suction pipe is provided with a cutter driven by an independent engine. The cutter and supporting frame are very heavily built and braced and designed for excavating very stiff clay. The discharge pipe is carried on floating pontoons to the shore line and from there to the point of discharge is laid on the ground.

It is not expected that it will be possible or advisable to pump material into the dam and up to the full height with a single pump. It has been found that about 75 ft. head against a sand pump is about the economic limit, as beyond that the necessary peripheral velocity of the pump runner becomes so high that the wear is abnormal. By "head" is meant the total head against which the pump is operating, and will consist of friction in the pipe, velocity head, and the actual lift or state head.

When the head has reached the maximum economic limit it is proposed to use a relay pump. This will be a pump similar to the one on the dredge, but motor driven, and will thus not require any steam plant or foundation, and but little attendance. It will be placed at the end of the discharge pipe, which will lead directly into the suction side of the pump. Its discharge pipe can be extended till the head on the second pump has reached the same limit, when another pump can be added, and this repeated as often as necessary.

It is, however, improbable that more than two pumps on one line will be needed. These dredges have not been completed and are not in operation. Two of them are also being built for the construction of the dams at the Pacific end of the canal, as proposed by the board of consulting engineers. The canal commission has just recommended the construction of locks at Miraflores instead of La Boca, which will obviate the necessity of dams near La Boca, but will necessitate the excavation of several miles of sea-level canal, for which work these dredges are admirably suited.

As tending to show the relative capacity of the dredging plant I have described, I will refer to the amount of excavation during the month of November, 1907. During this period the three ladder dredges, three dipper dredges, and one sea-going suction dredge excavated and removed 792,000 cu. yds., while the total amount removed by steam shovels from the Culebra division was 788,000 cu. yds., or the seven dredges removed 4,000 cu. yds. more than 42 shovels. Of the total amount dredged, 304,000 cu. yds. was taken out by the dredge Ancon, which is at the rate of nearly 600 cu. yds. per hour for every working hour she was in commission during the month. The average amount excavated per day of eight hours per shovel is 784 yds., or 98 cu. yds. per hour.

GAS-DRIVEN BATTLESHIP.

Naval officers and men who are interested in gas engines as a means of propulsion for vessels of large size were deeply interested in the reports from London that the admiralty had given orders for a 19,500-ton battleship, the St. Vincent, which would depend upon gas for motive power.

Lewis Nixon said that he had no doubt that the gas-engine battleship would prove an immediate success.

"This type of battleship," he said, "is the next great advance in naval construction. I looked very carefully into the matter of gas engines in Europe during the past few weeks. We are far ahead of the foreigners in every particular. Of course, one reads of wonderful achievements with kerosene engines, but, upon investigation we find them following a line of development already proven out here and abandoned.

"For all light, fast-running boats, the gasoline engine is the very best, even up to powers of 20,000 horse.

"For battleships, the coal-gas producer will be used, and this was outlined years ago, being predicated upon results already achieved in gas production. Gas engines on land are rapidly replacing steam. They use gas from inferior coals, blast-furnace gas, and illuminating gas for small units.

"On boats, we have unlimited water for cooling and scrubbing purposes, and the producer plant can be as readily installed as on land. A great deal of weight can be saved by intelligent design, and the total weight of machinery will be less than with steam boilers and engines.

"England evidently intends to keep ahead, even if she must borrow ideas elsewhere; and, as I cannot see that we can get gas engines adopted here till she uses them, I welcome the pioneer in such work, and only wish I had the chance to do the same.

"The English navy will soon have efficient gasoline torpedo boats, and their enterprise will then be applauded —probably imitated. When she built the Dreadnought other nations wanted to abandon their types of fighting ships and build the same.

"Then quietly comes the 28-knot Indomitable, an armored cruiser—the true cavalry of the seas—and I suppose we'll have some more switching. The battleship referred to can be built, and must soon be built; and, if it is produced, and successful, it will be another example of the enlightened statesmanship of Great Britain, which aims always to control the seas by controlling the building of the world's vessels. One design of battleship prepared by me had triple screws, with 12 cylinders, 30 in. by 30 in., on each shaft, 30,000 H. P. in all."

BOSTON MARINE NOTES.

Boston, June 17.—The turbine steamer Harvard of the Metropolitan Line, on her trip from Boston to New York, June 6, broke all previous records between the two named ports. The Harvard left India wharf at 5:03 P. M., and reached pier 45, North river, at 7:03 the following morning, making the trip in exactly 14 hours.

Pollock Rip Shoal lightship No. 73, Capt. Studley, has been temporarily withdrawn from her station in Vineyard sound and is now at the works of the Fore River Ship Building Co. undergoing repairs to her engine and boilers. She had been previously drydocked at East Boston, where her bottom was scraped and painted. No. 73 has been on duty for two years continuously, and during that time her bottom had become covered with sea growth. Her station is being covered by relief light vessel No. 66, which has the same characteristics of fog whistles as the No. 73.

Collector Lyman of the port of Boston announces that he is ready to accept proposals for a site for the new custom house for which Congress recently appropriated $500,000. The lot must be centrally located, bounded on all sides by streets, and containing not less than 20,000 sq. ft. Each proposal must be accompanied by a diagram indicating the principal street in the vicinity, the grades and dimensions of the land. Each proposal must be sealed, marked "Proposal for new custom house site at Boston, Mass.," and mailed to the secretary of the treasury, supervising architect, Washington, D. C. A special proposal form is not required, but all proposals must be in the hands of the secretary of the treasury by June 30, at which time all proposals will be opened.

It has been announced that employes at the Boston navy yard, who have been on short time for more than six

months past, will again go on full time July 1. The regular working force at the navy yard is about 2,900 men, but when the battleship fleet departed for the Pacific this number was reduced by discharging 900 workmen, and the balance were placed on half time.

The Electric Boat Co., with works at Quincy, Mass., announces their regular quarterly dividend of 2 per cent on the preferred stock, payable July 3, to stock on record June 20. Common, 1¾ per cent quarterly, June 30.

QUESTIONS FOR MASTERS AND MATES.—NO. 2.

20. What is meant by the direction Ely. and Wly. on the face of a compass card?

21. Which way does Ely variation carry the ship if not allowed for?

22. Which way do you allow Ely. variation in converting a true to a correct magnetic course?

23. Where do you find the variation of the compass?

24. Is the variation given in degrees or points?

25. How do you get the mean or average Var. between points of departure and destination, or to a turning point in a course?

26. What is meant by the annual change in the variation of the compass and what is the reason for it?

27. What two kinds of variation have we on the lakes?

28. Trace the line of "No Variation" through the lakes.

29. What does this line indicate?

30. What is the correct magnetic course between Detour and Presque Isle?

The true course is NNW ¾ W.

31. If your compass is correct how should it read in range with Frying Pan and Pipe Is. lighthouse? If your compass reads N ⅝ W, how much and which way is the Dev.?

32. Milwaukee piers run true E. and W., the variation is 3½ deg. Ely. If your compass were correct how should it read coming out parallel with these piers? If it reads E x N, how much and which way is the deviation?

33. What is the difference between variation and deviation? What is the reason for each?

34. Define local attraction and tell where it exists on the lakes.

35. How many one point courses are there on the compass card? Name them.

36. How does NNW derive its name?

37. What is the meridian of the compass and why is it so called?

38. Define meridian. What are the meridians on a chart?

39. Is 6 fathoms a "mark" or a "deep?"

ANSWERS TO QUESTIONS FOR MASTERS AND MATES.—NO. 2.

20. Ely. to the right. Wly. to the left.

21. To the right.

22. To the left.

23. On charts.

24. In degrees.

25. Take half the sum of the Var. at points of departure and destination, if of the same name. If of contrary names you would have to make two courses of it, unless the amounts were equal.

26. The yearly increase or decrease. The reason for it is that the magnetic poles change their position from year to year with reference to the true poles.

27. Ely. and Wly.

28. Latest variation charts show the line of no variation as passing through Lake Superior from a point just west of the Slate Is. to a point just east of Grand Is., thence down through the north end of Green bay and diagonally across the north end of Lake Michigan to a point south of S. Manitou Is.

29. That there is no variation of the compass along this line.

30. True course NNW ¾ W, mean variation ⅜ pt. Wly. C. M. course, NNW ⅜ W.

31. True bearing N 5° W, variation 4° Wly. Compass should read N 1° W. If compass reads N ⅝ W, the deviation is ½ Pt. Ely.

32. E ¼ N. ¾ Pt. Ely.

33. Variation is the difference between the true and the magnetic meridians and is caused by the true poles differing from the magnetic poles. Deviation is a disturbance of the needle caused by the magnetism in the ship, her equipment or cargo.

34. The disturbance of the compass needle by magnetic influence existing outside the ship. Along the north shore of Lake Superior in the vicinity of Grand Marais, Stony Pt., Split Rock and Knife Is. Also about the magnetic reefs N shore of Lake Huron.

35. Four. N x E, N x W, S x E. S x W.

36. It is the point half way between N and NW and partakes of the name of each.

37. The north and south line. Because all courses are reckoned from it.

38. A meridian is an imaginary great circle on the globe passing through both poles. On the chart they are the N and S lines designating longitude.

39. Six fathoms is a "deep."

QUESTIONS FOR WHEELSMEN AND WATCHMEN.

511. Where are South Fox Island shoals?

512. How are they marked and what is their extent or area?

513. What kind of a passage between South Fox Island shoals and North Manitou Island?

514. Where is South Fox Island passage proper?

515. What is the least width of the passage between North and South Fox Islands?

516. What winds and sea does South Manitou Island harbor afford protection.

517. How is the holding ground?

518. Describe South Manitou Island?

519. Why is it dangerous for a deep draughted vessel to approach South Manitou Island from the SW?

520. What is the least width of the passage between Pyramid Pt. shoals and the shoals lying to the south'ard of North Manitou Island?

ANSWERS TO QUESTIONS FOR WHEELSMEN AND WATCHMEN.

500. S by W ⅝ W, 203 miles.

501. S by W ⅜ W.

502. Add together the variation at Chicago and at Pt. Betsey and divide the sum by 2, or the mean of the sum and apply it to the true course.

503. N by E ⅝ E.

504. NE ⅜ N 29½ miles.

505. NE ⅞ N.

506. One mile.

507. About S by E 7 miles.

508. S ⅝ E 2 3/5 miles.

509. North Manitou Island shoals; Pyramid Pt. Shoals; shoals south of South Manitou Island and Good Harbor shoals. The North Manitou Island shoals are the only ones marked.

510. About 9 miles.

Three Japanese stowaways, brought to New York from Yokohama on the British bark Lawhill, picked the lock of the room in which they were detained last Friday and made their escape from the vessel. They were to be deported on the steamer Narragansett.

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OMNIBUS NAVIGATION BILL.

Congress at its first session passed an act for the protection of life on seagoing barges which has much merit. It requires that the local inspectors of steamboats shall at least once a year inspect the hull and equipment of every seagoing barge of 100 gross tons and over and shall satisfy themselves that such barge is a structure suitable for the service in which she is employed, has suitable accommodations for the crew and is in a condition to warrant the belief that she may be used in navigation with safety to life. It is further provided that every seagoing barge shall have at least one lifeboat, at least one anchor with suitable chain or cable, and at least one life preserver for every person on board. The owner of a barge violating these provisions is liable to a penalty of $500 for each offense.

In addition the act empowers the department of commerce and labor to enforce regulations limiting the length of hawsers between towing vessels and seagoing barges. This bill is designed to regulate what is regarded by experienced navigators as the most dangerous form of navigation along the seaboard. There are between 400 and 500 seagoing barges of over 100 gross tons employed in coastwise traffic at present. During the past two years 60 of these barges have been lost with an accompanying loss of 49 lives, a greater proportion than exists in all other forms of marine casualty. Many of these barges represent the last stages of once well-designed and well-built ships and barks. As they proved useless for the trade for which they were originally projected they were dismantled and cut down into barges, frequently having large hatches made in them which of course rendered them structurally weak. As they have no independent means of navigating they are practically helpless when the hawser breaks.

In numerous instances of wrecks and collisions which have been brought to the attention of the federal courts the courts have not hesitated to condemn the practice and to regret its inability to remedy it. In the Berkshire case the United States district court of appeals said: "The Berkshire produces many opinions that the make-up in the tow in this respect was faulty, but it is mainly based on the hypothesis of a hawser 100 fathoms in length. Independently of this it is beyond the province of the courts to condemn a practice as notorious and so long continued that it must be presumed to be known to congress and to the supervising inspectors, and yet has not been condemned by either of them."

This bill is the first step that congress has taken to remedy this method of transporting freight. It would seem to be in every way a sensible measure. The barge once loosed is virtually a derelict, and is a menace not only to those aboard her but to everyone she encounters.

The omnibus navigation bill is a consolidation into one act of eight separate measures. Some of the amendments to existing measures are of minor importance. The present statute provided no penalty against a steamer for carrying unlicensed engineers except when such unlicensed engineer should be in charge of a watch, and it provided no penalty for a person serving as an engineer without being licensed except he act in charge of a watch. The amendment provides that a steamer may not carry an unlicensed engineer under any circumstances.

The law requiring steamboats to keep the names of passengers was amended to keep the number only except in the case of seagoing passenger steamers in the coasting trade and on the great lakes on routes exceeding 300 miles in length. The purpose of the measure is to correct and relieve an almost impossible and impractical requirement respecting excursion steamers carrying large numbers of passengers on inland routes. Since the original act was passed the speed of steamers has increased so much that especially in the case of day excursions it is as impracticable to obtain the names of those on board as it would be in the case of an excursion train.

The international signal code provides means of indicating from a distance at sea the names of vessels. The letters to which these signal flags correspond are carried officially by the bureau of navigation, department of commerce and labor. Certain lights are provided by the rules for preventing collisions and "no other lights which may be mistaken for the prescribed lights shall be exhibited." As a further means of recognition at sea vessels have "house flags" and "funnel marks," indicating the lines or owners that they belong to. They also have special parti-colored rockets for the same purpose. These devices are recognized by law in other countries and are desirable. Some years ago the secretary of the treasury allowed these house flags, funnel marks and rocket signals to be registered informally, and they have been so registered in the bureau of navigation. This registry is without author-

ity of congress, and is of no validity This section will legalize such registry and give these special signals the same recognition by law which they have under foreign laws.

A bill was also passed compelling scows and similar vessels carrying the refuse of New York City out to sea to be dumped to be equipped with rails or ropes, life buoys and simple appliances necessary to the safety of life. The situation which this amendment is designed to meet is doubtless familiar to those doing business in New York harbor. When loaded these mud or garbage scows have practically no freeboard and the decks are awash at times merely from the passing of large ocean steamers entering or leaving port. In rough weather which at times prevails in the lower bay and out at sea where refuse must be dumped the position of those on board is pitifully perilous. There is no accurate record of the number of men washed overboard from these scows and drowned, but the press of New York shows that such casualties are not infrequent. The need of the guard rail or rope and life preserver and life buoy are thus evident. The bill also provides that such scows shall carry an anchor. The scows are usually taken to sea in long tows and if the line parts the scow becomes helpless. The anchor will serve to minimize the danger.

LAKE FREIGHT SITUATION.

At the meeting of vessel owners held in Cleveland on Tuesday, no further postponement of the opening of navigation was made and vessels will now leave port as occasions may require. Certain independent owners would have preferred a definite agreement not to move until July 1, as business conditions are not sensibly better than they were two weeks ago. No action was taken, however, which leaves the situation open and vessels will leave as soon as cargoes can be secured. All of them are now fitting out and probably a greater part of them will be ready for business by the close of the present week. It must be admitted, however, that there is not very much business in sight and that the demand for wild tonnage will not exist until July. Shippers are having about all that they can do to provide ore cargoes for their own vessels. Of course there is considerable movement of coal, but it is not altogether satisfactory to the wild owner to carry a cargo of coal to the head of the lakes and then come down light.

It will probably take a month to get things going smoothly. The capacity of the shipping docks is not more than half engaged and delays at upper lake ports are likely to result. Should the movement of ore become heavy later in the season the dock situation is likely to become troublesome. Not all of the docks are in operation. There is no doubt whatever of the ability of the fleet to move 30,000,000 tons after July 1 provided dock dispatch is reasonable. No one, however, expects the movement to reach this figure.

Some bustle and activity is beginning to replace the scenes of stagnation that have presented themselves at various ports. For instance, the seven great steamers of the Cleveland-Cliffs Iron Co., which have been lying in ordinary at Ecorse, are now preparing to go into commission.

The active attitude of labor toward the open shop is problematical. Naturally the unions are adopting resolutions in opposition to it, but whether a strike will be ordered remains to be seen. Operators for some time past have been preparing for any emergency that may arise.

PIG IRON SITUATION.

The reduction in the prices of crude steel and some finished products has been followed by little, if any, increase in demand for anything except steel bars, for which manufacturers of agricultural implements have contracted a fair amount. The railways and the steel interests have practically reached an agreement as to steel rail specifications, and it is expected that large orders will be placed at a not far distant date. The reduction of 50 cents per ton in iron ore was made in harmony with the wishes of steel makers and furnace operators. Pig iron prices are well maintained, although selling is not active. Increased activity is reported in the coke market, and contracts amounting to 200,000 tons of furnace coke have been made in Pittsburg.

GREAT LAKES RED BOOK.

The Great Lakes Red Book is now out and deliveries can be immediately made by the Penton Publishing Co., Cleveland. The book is the most complete that has ever been issued. During the past three or four years it has been the practice to organize separate companies for the ownership of single steamers, though quite a number of these separate companies are controlled in one office. Frequently, however, it has been a matter of some doubt to the postal authorities as to the address of the single company and to others as to the steamers controlled by it.

The 1908 edition of the Red Book has endeavored to record all of these companies and to indicate the steamer or steamers controlled by them and the firms that manage them. Unfortunately the book is not quite complete in this respect as some of the managing firms failed to supply the names of the companies incorporated to own individually the various steamers managed by them. It is hoped next year to make the book complete in this particular, as the information is really important.

AROUND THE GREAT LAKES.

The ice crusher Santa Marie, operating in the Straits of Mackinaw, has been taken to the dry dock at Detroit for repairs.

The Durolithic Co., of Buffalo, has been awarded the contract for building the marine hospital at that port for $82,861.

The new steamer Charles W. Kotcher left Lorain on her maiden trip June 16 with a cargo of coal for Washburn.

The Canadian steamer Wexford which grounded outside of Buffalo harbor with a cargo from Fort William had to have 400 tons of flaxseed lightered before she was released.

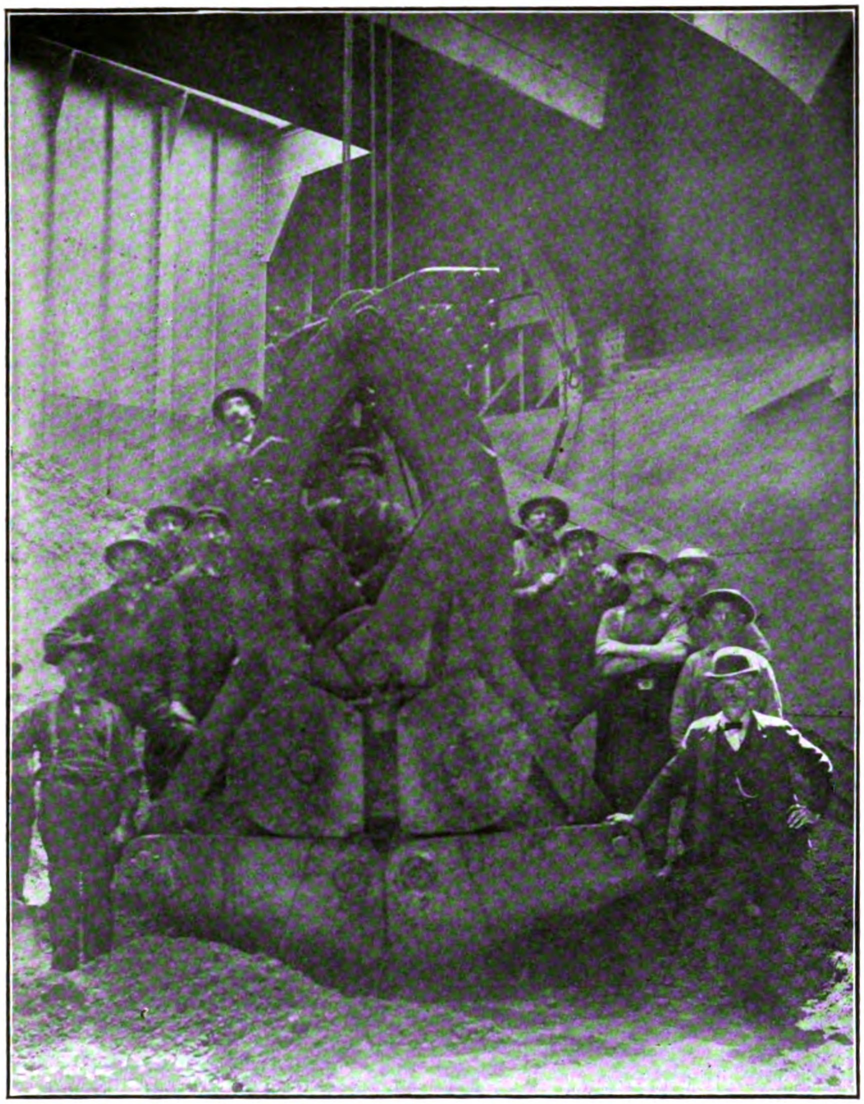
Capt. Harris W. Baker, of Detroit, who recently purchased the steamers Chauncy Hurlburt and Samoa at United States marshal's sale, is spending $7,000 in fitting them out for general trade.

The first cargo of iron ore to be shipped to the Lackawanna Steel Co.'s plant at Buffalo arrived on June 12. Last year the first ore cargo was received at the Lackawanna plant on April 18.

The little Canadian schooner Sligo with a cargo of coal from Pelee Island was badly shaken up in a storm on Lake Erie this week and had to put in at the port of Cleveland for shelter.

The steamer Empire City of the Pittsburg Steamship Co.'s fleet was the last of the 17 boats of the company wintering at South Chicago to go into commission. She left for Superior on June 10.

Mr. W. J. Stewart, chief hydrographer, department of marine and fisheries of the Dominion government, has just issued two charts of Lake Superior, one from Lamb Island to Thunder Cape, and the other from the head of Thunder Bay to Pigeon river. Both charts are in colors.



THE HUNTSBERY CLAM SHELL BUCKET IN THE CLOSED POSITION.

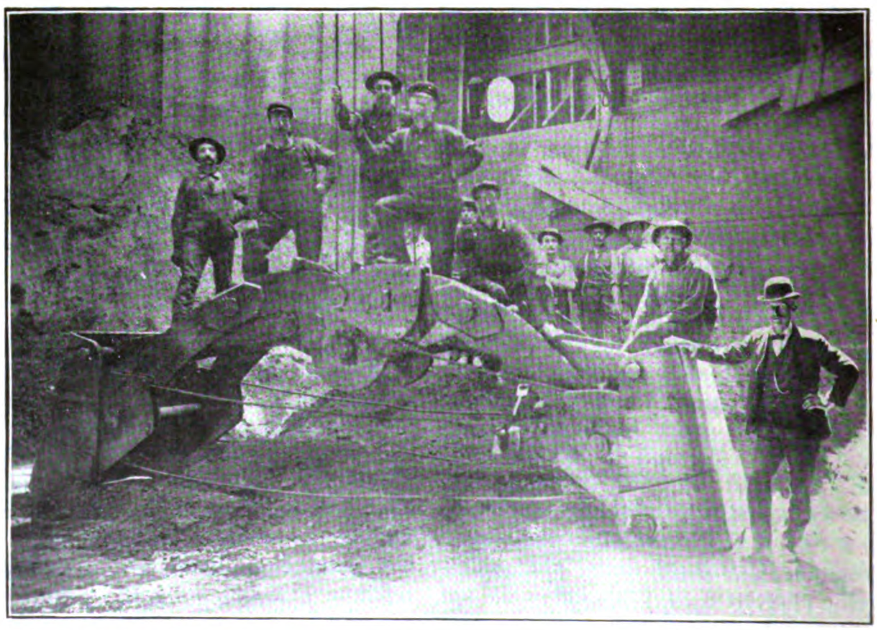
NEW CLAM SHELL BUCKET.

A clam shell bucket of new design has just been invented by H. E. Huntsbery, of Cleveland, and installed on the Cleveland & Pittsburg docks in connection with a Hoover & Mason unloader. Two views of the bucket at work in the hold of the steamer B. F. Jones are presented herewith, one view showing the bucket open ready to grab the ore and one showing the bucket closed with a load ready to be hoisted out of the vessel.

Mr. Huntsbery claims a great advantage in his bucket in the extremely wide opening which is obtained without increasing the height or complexity of the structure. The bucket has a full opening of over 18 ft. with a capacity of over five tons of ore. Its reach is therefore 5 ft. greater than any bucket on the market, and its average load is considerably in excess of other buckets. It can be operated on any design of unloader using either steam or electricity. C. E. Cole, superintendent of the Cleveland & Pittsburg ore dock, is very favorably impressed with the advantages gained by reason of the wide opening and the simplicity and durability of the construction.

This experimental bucket, which was built by the Macbeth Iron Co., under Mr. Huntsbery's supervision, has now been working for the past two weeks and has met all the expectations of its inventor. It appears to possess many advantages and is especially adapted to the rapid unloading of the 24-ft. center boat with hatch openings running 12 ft. fore and aft. The advantage of an 18-ft. reach is obvious as it practically eliminates shoveling by hand. Another advantage is in the position of the trays when the grab is open, as the digging edge of the trays comes in contact with the bulkhead or wing of the boat only, while the top of the trays are over 18 in. from either bulkhead, wing or stanchion when the grab is open, thus taking the ore perfectly clean from any part of the vessel.

When the grab is dropped the entire lower edge of the trays comes in contact with the tank top, obviating any damage either to the tray or to the tank top. Moreover, the mechanism is so designed as to give it a perfect digging action, avoiding all undue thrusts or strains, and thus tending to keep the cost of maintenance low. The parts are few and the bucket should not readily get out of order.



THE HUNTSBERY CLAM SHELL BUCKET OPEN, SHOWING ITS ENORMOUS REACH.

One of the advantages of this bucket which will impress the experienced operator is its ability to assist in unloading ore from an adjoining hatch. For instance, the operator by leaving some ore in the center of his hatch may lower the grab to the hold of the boat in the closed position and by pressing either tray against the ore in the center of the hatch and opening the grab from this point he will obtain a reach of 18 ft. in either direction. Thus if one rig should get out of order from any cause the two adjoining rigs could unload nearly all of the ore from a 24-ft. center boat without shifting either the rigs or the boat.

SEAGOING BARGES.

Concerning the bill to govern seagoing barges (S. 6,487) incorporated in the omnibus navigation bill, published elsewhere in this issue, Oscar S. Straus, secretary of the department of commerce and labor, wrote the following letter to Secretary Frye:

"In compliance with your request that I furnish the committee with such suggestions as I may deem proper touching the merits of the bill and the propriety of its passage, I have to say that the department favors the bill in the interests of safety to life on the waters.

"The bill is designed to regulate, so far as may be feasible at this time, the most dangerous form of navigation along our seaboard. There are between 400 and 450 seagoing barges of over 100 gross tons employed at present. During the past two fiscal years 60 of these barges were lost. Of the 60 vessels lost, 49 were built before 1898, and nearly half were over 30 years old. Many of these barges years ago were stanch ships and barks. As they have deteriorated they have been dismantled, and large hatches have been cut in them, rendering them structurally even weaker. When from any cause these towed barges break loose from the towing steamer, those on board are practically helpless. Of 192 persons on board these 60 barges 49 lost their lives, or over 25 per cent, a death rate far in excess of the rate in other classes of marine casualties here or abroad. These figures do not include the loss of life on board other vessels with which these barges in tow have collided.

"The first section of the bill provides for an inspection of the hulls of such barges similar to the inspection to which the hulls of seagoing freight steamers are subjected under sections 4421 and 4423, Revised Statutes. The second section requires a simple but indispensable life-saving equipment. In many instances, doubtless, this equipment is now provided; it should be required in all instances.

"These barges are not only at times structurally unseaworthy and dangerous to the crew on board; they are also when in long tows a source of danger, especially in harbors, bays, and sounds of the seacoast, to passenger steamers and sail vessels. During the past dozen years the federal courts have often called attention to this danger. In the case of the Gertrude, the circuit court of appeals for the first circuit on July 29, 1902 (118 Fed. Rep., 131) held:

"'We have several times urged on the attention of all who might come within range of our opinions the extremely dangerous character of this method of navigation and the consequent extreme care to which we must hold a tug under these circumstances, although we have no power of prohibition in the absence of congressional action. This case impresses us anew with the necessity that the courts should hold a firm hand and, indeed, with the propriety of congressional interference. As the result of the collision the Silliman was sunk and all hands on board lost.'

"In the absence of legislation the federal courts have held that it is beyond their province to condemn a practice so notorious.'

"The lighthouse authorities state that such long tows imperil light vessels and other safeguards to navigation.

"The commercial and navigation interests, steam and sail, have brought the subject to the attention of the department of commerce and labor, and are understood, as a rule, to favor this bill.

"Section 5 of the bill authorizes the secretary of commerce and labor to issue and enforce regulations limiting the length of hawsers and of such tows. It is not feasible to frame a statute directly fixing such lengths, because different rules should be applied in different waters, where the conditions of the channel, its ease or difficulty, its currents, bends, density of traffic, etc., must be considered. The discretionary power asked for the department of commerce and labor is materially less than that already granted in the matter of the equipment of steam vessels, and is no greater than powers concerning towing vested in administrative officers in foreign ports."

GREAT LAKES SUPPLY CO.

The Great Lakes Supply Co. now has a store at both Duluth and Buffalo. The Duluth store is a new one, just opened this season for the accommodation of the boats that make that upper lakes port. It is located in a three-story warehouse building on the dock at Nos. 245-247 Lake avenue, S., with C. D. Garrison in charge as manager for the company. A launch service is run in connection with it for the convenience of customers.

Besides its ship chandlery and engineers' supplies business, the company is carrying and furnishing to the trade a full line of groceries and meats, as well as ice. It has its own ice house and its own dock and railroad switch.

At the company's store in Buffalo, which is located in the building formerly occupied by the Buffalo Ship Chandlery & Supply Co., 11-13 Main street, a full line of groceries is also carried in addition to the ship chandlery and engineers' supply lines. As at Duluth a launch service is furnished.

Several of the steamship owners of the great lakes are interested in the company.

TURBINES YALE AND HARVARD.

The conclusion based on the experience of last season that the patronage of the new express steamships of the Metropolitan Steamship Co., plying between New York and Boston on the outside all water line would be large has been more than verified, even during the opening weeks of the season, for night after night the passenger list has exceeded expectations, and has steadily increased. The Yale and Harvard are carrying a very large share of the travel between the two cities. As to the schedules of these two great ships it may be said that during the last two weeks they have been reaching their destinations nearly every day before 7:30 in the morning, thus beating their advertised run of 15 hours. Considering the distance covered this record is remarkable.

The hurricane deck cafe for men and the writing room for women and men together with other innovations are much appreciated by passengers who are traveling on the great turbiners daily between the two great cities New York and Boston.

The car ferry Sainte Marie went to the dock of the Detroit Ship Building Co. this week for extensive repairs, including a general overhauling of the boilers.

ATLANTIC COAST GOSSIP.

Office of the MARINE REVIEW,
Room 1005, No. 90 West St.,
New York City.

Last week the Lusitania arrived at New York, bringing with her some new records. The passage from Daunt's Rock to Sandy Hook lightship was made in 4 days, 20 hours and 8 minutes, just 14 minutes better than her own best previous record on the long course, and 7 minutes better than the record made by the Mauretania. The Lusitania covered 641 miles for one day's steaming, beating the record lately made by the Mauretania of 634 miles. An average speed of 24.88 knots was maintained by the Lusitania, as against 24.86 knots made by the Mauretania on her last record-breaking trip. The daily runs made by the Lusitania were, from noon to noon—69, 641, 621, 627, 603, and, to Friday at 1:08 A. M., when the lightship was abeam, 339 miles.

Now, Mauretania.

A banquet was given on board the Chicago, the new steamer of the Compagnie Generale Transatlantique, to the delegation of the Chicago board of aldermen who brought the solid silver cup presented to the ship by the city of Chicago, while the Chicago was in port last week. The presentation was in recognition of the compliment paid by the officials of the line to the metropolis of the west, the association of commerce, through its representative, C. B. Sheldon, also presenting the ship with a silver tablet and a resolution of thanks. The cup was presented by Linn H. Young on behalf of the mayor of Chicago. Mr. Faguet, general agent of the French line, thanked the representatives of the city on behalf of the owners of the vessel.

There arrived at New York on Saturday the steamship Russia, the first of four vessels to enter the passenger service of the Russia-American line being built at the yards of Messrs. Barclay, Curle & Co., Glasgow. The Russia and her sister ships will each have a displacement of 16,000, propelled by twin-screw quadruple-expansion engines, and will develop a speed of 17 knots. She has accommodations for 40 first class passengers, 58 second cabin, 264 first class steerage and 1,400 second class steerage. It is intended that a weekly service will be maintained between New York, Rotterdam and Libau, when the four vessels are in commission.

The new steamer Rotterdam, of the Holland-America line, which left Rotterdam last Saturday for New York, is the fourth vessel of the same name built by the line. The first Rotterdam appeared in 1872, and was a vessel of 2,000 tons; the second Rotterdam was built in 1885, and was of 4,500 tons; the third was of 8,300 tons, twin screw, and was built in 1897. The new Rotterdam is the third largest liner in the trans-Atlantic service.

The McClintic-Marshall Construction Co. has been awarded the contract for the new pier of the Holland-America line, requiring about 3,000 tons of steel.

The British steamer Coya and the Norwegian steamer Hagin were in collision about 160 miles southeast of Hatteras on the night of June 13. The vessels met head on in the darkness and were both badly damaged. The Hagin arrived at New York on Tuesday with her bows stove in, the Coya putting into Portsmouth, whither she was bound. The Hagin left New York for Cuba, but put back after the collision.

The steamship Merrimac, Captain Pratt, arrived at Savannah on June 11, bringing the survivors of the British tank steamer Caribbee, which was lost in the gulf stream three days previous. The Caribbee sprang a leak and had to be abandoned, the crew being picked up in the boats by the schooner Theoline and later transferred to the Merrimac. The Caribbee was formerly the steamer Merionethshire, of 1,245 tons net, and was built at Glasgow in 1878.

The White Star line steamer Baltic sailed for Liverpool last week with the largest passenger list of any ship leaving the port of New York this season. There were 402 first class, 378 second class and 1,207 third class passengers. The total number was 1,987, and with the officers and crew of 400, 2,387.

The new North German Lloyd steamer Prinz Friedrich Wilhelm arrived this week at New York, from Bremen and Cherbourg. She was built at the yards of Tschlenbor & Co., Geestemunde, is about 550 ft. in length and has a gross tonnage of 17,082. She has been built for 17 knots, but logged nearly 17.5 on her maiden voyage.

The new French liner Chicago, which arrived at New York last week on her maiden voyage, is 524 ft. long, beam 57 ft., and 43 ft. deep. She is a twin screw vessel, her engines indicating 9,500 H. P., built for an average speed of 16 knots. There are accommodations for 314 second class and 1,250 steerage, the Chicago having been designed to suit the second class and steerage trade.

The American liner St. Paul, which has been undergoing repairs since her collision last April with the British cruiser Gladiator, will resume her running on June 20, when she will leave Southampton for New York.

The American Dredging Co. has been awarded a contract by the government for dredging in the Delaware river near Bordentown, N. J., for a distance of 3,500 ft. to a depth of 7 ft. at low water.

The big schooner George W. Wells left Philadelphia last Friday evening with 4,700 tons of coal for Portland. She was drawing 28½ ft. of water.

Trans-Atlantic liners are encountering an extraordinary number of icebergs.

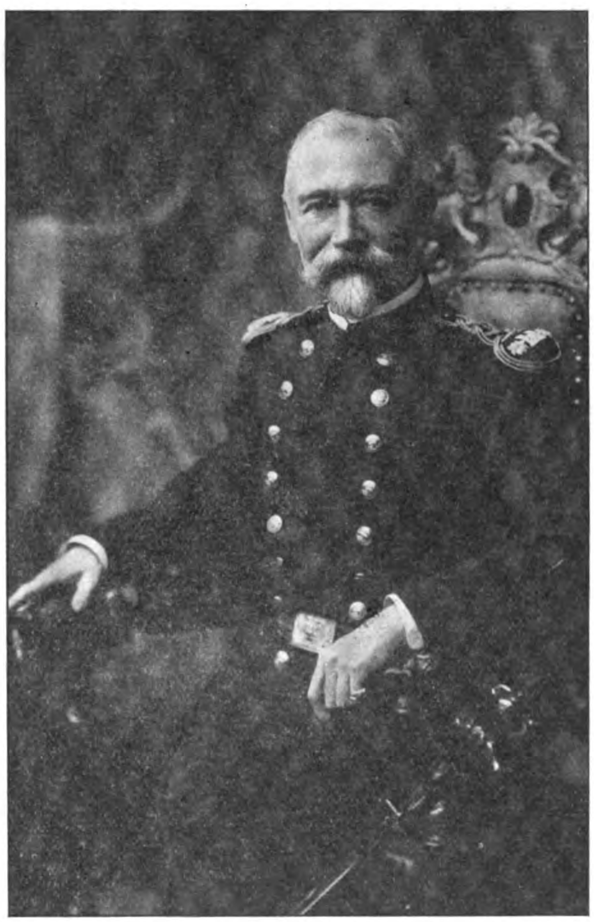
PRINZ FRIEDERICH WILHELM.

The Prinz Friedrich Wilhelm, one of the biggest of the North German Lloyd's big ships, arrived at New York on her maiden trip from Bremen, Southampton and Cherbourg. She is not a flyer, but she is as finely fitted as the racing ships of the line and can make Sandy Hook from Cherbourg inside of eight days. She is 613 ft. long and displaces 25,500 tons, being exceeded in size only by the Kronprinzessin Cecilie and the Kaiser Wilhelm II. She is the largest vessel ever built on the Weser. Excluding those for the finest suites, the ship has 32 baths for first cabin passengers, nine for second class passengers, and 100 or more wash houses, shower baths and wash basins for the third class passengers and the crew. She can carry 10,500 tons of freight, including perishable stuff, for which she is equipped with two immense cold storage rooms lined with 100 tons of leaf charcoal.

A slight error occurs in the present issue in the advertisement of the Ekenberg Milk Products Co. The line line reading "ten cent cans" should read "ten pound cans."

GEN. MACKENZIE RETIRES.

Brig. Gen. Alexander Mackenzie, chief of engineers, U. S. A., was retired from active service on May 25, with the grade of major-general, having reached the legal retiring age of 64. He was graduated from the Military Academy in 1864, and at once entered the field in the civil war operations on the lower Mississippi, receiving the brevet of captain for gallant and meritorious service. After the war he was engaged in a great variety of river, harbor and canal work in different parts of the country, principally in the Mississippi and Ohio valleys. He became colonel in 1901 and brigadier-general in January, 1904, when he was appointed chief of engineers. He is an honorary member of the American Society of Civil Engineers, and recently served on the inland waterways commission.



GEN. ALEXANDER MACKENZIE.

PERSONAL.

The title of "Doctor of Engineering" was conferred upon Frank E. Kirby, the noted naval architect and marine engineer, this week, by the University of Michigan.

ITEMS OF GENERAL INTEREST.

It is announced that the Maryland, armored cruiser, made 22.25 knots on a four-hour, full speed, forced draft trial recently, exceeding the speed made on the contractors' trials.

The issue of the MARINE REVIEW for May 14 contained a paragraph at page 32 to the effect that a foreign vessel, wrecked in the United States, may be registered by the commissioner of navigation under certain conditions. Section 4136, revised statutes, which contained this law, was repealed Feb. 22, 1906.

Obsolete ships of the British navy were sold at Sheerness dock yard last month for prices varying from £21,700 for the battleship Devastation, built in 1871 at a cost of £430,746, to £900 for a gunboat built in the same year at a cost of £11,712. A wooden line of battleships built at Bombay in 1831 fetched £5,573, and a hulk of 1814 £1,800.

Beginning with the July issue, the *Engineer and Fireman*, published by the Penberthy Injector Co., Detroit, Mich., will be increased from 32 to an 80-page magazine with 10,000 monthly circulation and full of interesting and instructive reading matter of a mechanical nature. Free sample copy will be mailed to any reader of the MARINE REVIEW upon request.

The removal of obstructions in the East river in the vicinity of Hell Gate, at Pot Rock, Frying Pan and Middle Reef is now under contract, and the contractors expect to start work this week. This notice is given in order that marine transportation interests may, while passing this vicinity, take more than ordinary care to avoid injury to their own craft and to the plant of the contractors.

No better proof of the great advance in warship construction in the century that has passed since the battle of Trafalgar can be given than by a comparison between Lord Nelson's famous ship Victory and Britain's latest pride, the Dreadnought. It took 16 months to build the Dreadnought and five years 10 months for the Victory, while the former cost $8,987,485 and the latter $445,000, or one-twentieth. The difference in displacement is about five times, or 17,900 tons against 3,400.

The decision of the trial judge in the case of the collision between the Canadian Pacific steamer Princess Victoria and steam schooner Chehalis at Vancouver, July 21, 1906, which laid the entire blame for the accident on the latter, has been reversed by the supreme court, which has awarded $26,000 to the Chehalis. The owners of the steamer will appeal the case to the judicial committee of the privy council in England.

Contracts have been awarded the Fore River Ship Building Co. by the war department for the construction of eight single-screw steamers for the sea coast artillery service. Seven of these steamers will be fitted with Scotch boilers, while one will be fitted with Babcock & Wilcox boilers. The principal dimensions of the new boats will be as follows: Length between perpendiculars, 91 ft. 4 in.; beam, 22 ft.; depth, 10 ft. 11 in.; and on trial will have a speed of 10½ miles per hour.

OBITUARY.

Capt. Wm. Crawford, an old time tug man well known in Chicago, died at his home in Wheaton, Ill., last week.

John Baker Roach, president of the Delaware River Iron Ship Building Co., better known as Roach's Ship Yard, died at his home at Chester, Pa., on June 16, of paralysis.

The Subject of Time

DIVISIONS OF TIME.

Astronomers make use of two different kinds of time; mean solar time, which is to be distinguished from true, or apparent solar time; and sidereal (star) time.

THE SIDEREAL DAY.

The interval between two consecutive transits of a fixed star over any meridian, or the interval during which the earth makes one absolute revolution on its axis is called a sidereal day, and is invariable, while the interval between two consecutive transits of the sun over any meridian is called an apparent solar day (true length of the day as measured by the sun), and its length varies from day to day by reason of the variable motion of the earth in its orbit, and the inclination of this orbit to the equator, on which time is measured.

Solar time is that used for all purposes of ordinary life, and is measured by the daily motion of the sun. This is the most natural and direct measure of time. The intervals between the sun's transits over the meridian being unequal, it is impossible to regulate a clock or chronometer so that it shall accurately follow the sun.

IMAGINERY OR MEAN SUN.

To avoid the irregularity which would arise from using the true sun as the measure of time, a fictitious sun, called the mean sun, is supposed to move on the equator with a uniform velocity. This mean sun is supposed to keep, on the average, as near the real sun as is consistent with perfect uniformity of motion; it is sometimes in advance of it, and sometimes behind it.

A mean solar day is the average or mean of all the apparent solar days in a year. Mean solar time is that shown by a well-regulated clock or watch, while apparent solar time is that shown by a well-constructed sun dial; the difference between the two at any time is the equation of time, and may amount to 16 minutes and 21 seconds.

Mean solar time, which is perfectly equable in its increase, is measured by the motion of the mean sun. The chronometers used by navigators are regulated to mean solar time.

True, or apparent solar time is measured by the motion of the real sun.

The difference between apparent and mean time is called the equation of time. By means of it, we change apparent to mean time or the reverse. Thus, if the apparent time be given, the mean time corresponding to it will be obtained by adding or subtracting the equation of time, according to the precept at the head of the column in which it is found, on page 1 of the nautical almanac for each month. If the mean time be given, the apparent time is obtained by applying the equation of time as directed by the precept on page 2 of the almanac.

Mean solar time is the hour-angle of the mean sun, and is called mean time.

Apparent solar time is the hour-angle of the actual sun, a body which is apparent to our sense of sight, measured from the meridian westward. The time which is denoted by the true sun is called the true, or more commonly the apparent time.

Apparent, or true noon, at any place is the instant at which the sun's center crosses the meridian of that place.

Mean noon is the instant when the imaginary sun crosses the meridian on which the observer is situated. Mean time then begins (that is, a mean solar clock shows 0h. 0m. 0s.) at the instant of the passage of this fictitious sun across the meridian.

THE EQUATION OF TIME.

The difference between the place of the real and imaginary sun is familiarly known to sailors as the equation of time. Sometimes the imaginary sun is ahead of the real one, and sometimes it is astern of it, depending on the period of the year. The fact as to which of the two is leading decides the application of the equation of time, as set forth in the precept at the head of its column in the nautical almanac.

The equation of time is so called because it enables us to reduce apparent to mean, or mean to apparent time. This is owing to the motion of the earth in its orbit, and as the earth is shaped like a tomato, its path or course, around the sun is likewise tomato shaped, and the sun being situated at one of the foci, instead of the center; hence, it cannot travel uniformly as it would were the orbit a true circle. These fluctuations are considerable, amounting sometimes to as much as a half hour—apparent noon sometimes taking place as much as 16 minutes before mean noon, and at others nearly as much as 14½ minutes after. These are the greatest values of the equation of time; it vanishes altogether four times a year —this occuring about April 14, June 13, August 31, and Dec. 23. To render this plainer, a sun dial shows apparent time; when the sun's shadow coincides exactly with XII on its dial, a clock keeping correct mean time, should show several minutes before XII or several minutes after XII, depending on the period of the year. At the instant the sun's shadow falls on XII the sun is on the meridian and bears true south, and the same instant of time is true, or apparent noon, which will differ from the time of mean noon by the amount of the equation of time for that day. The sun dial and clock set to mean time will agree exactly when the real and imaginary suns happen to coincide, or pass the meridian at the same time. This actually occurs four times in each year, and on or about the above named dates. It must be understood that the sun dial must be set to the true points of the horizon, the Roman numerals on its face, representing the points of the compass, as it were.

The equation of time is calculated and inserted in the nautical almanac for every day in the year. The difference between the values on opposite pages, though very slight, arises from the one being that of apparent noon, and the other mean noon. The equation of time is itself a portion of mean time.

If the earth's axis were exactly perpendicular to the plane of its orbit, and if the orbit itself were a true circle, all solar days would be of the same length. There would be no need of a mean, or imaginary sun, as the true sun would come to any meridian at precisely the same time each day, the same as the imaginary sun is now supposed and made to do. But the inclined axis and elliptical orbit of the earth causes a considerable variation in the length of the true solar days. For this reason, a perfectly regulated clock or watch does not and cannot keep time with the unequal motions of the sun. Such a clock shows the time that would be shown by the sun, if, as above supposed, the axis of the earth were perpendicular and its path a true circle. From one noon, or 12 o'clock, to another, as shown by such a time piece, there are always exactly 24 × 60 ×60 seconds. The length of the day thus shown is the exact average length of all the true solar days of the year. This average,

regular and unchangeable day is called the mean solar day, its noon is called mean noon, and the clock is said to keep mean time.

Owing to the inclined position of the earth's axis and the varying rate of motion in its orbit, true or solar noon sometimes lags behind mean noon, losing a little each day, until it is sometimes nearly 14½ minutes behind the regular mean noon; at other times of the year it gains on the mean noon, and little by little overtakes it, and at last gets about 16 minutes ahead of it. Thus, when the shadow of the sun is just on the noon or meridian mark along about Nov. 1, a good watch will show 16 minutes of 12; hence at this time of the year to know when the sun is exactly on the meridian of any place subtract 16 minutes from 12 o'clock true noon and the result is the time that the sun will cross the meridian according to mean time, or that shown by a clock regulated to mean sun time. When the sun is on the meridian along about Feb. 12, clocks set to mean time will show about 14½ minutes after 12. Only four times in a year will they agree.

Mean solar time has been in general use about a century. Before that, clocks had to be reset daily by the sun or noon mark.

A sidereal day is the period in which the earth performs one complete revolution round its axis, and, setting fractions aside, is equal to 23h. 56m. 3s. of mean time, as measured by our clocks or watches; so that the common expression, that the world rotates once in 24 hours, is incorrect, unless sidereal hours are either specified or understood.

The earth really rotates on its axis 366 times in the course of a year, but as we also make one revolution around the sun in the same period, the sun appears to travel round us only 365 times. In the language of nautical astronomy, the earth (for sake of convenience) is considered as standing still, and the heavens to be moving about it.

A sidereal, or star day, is shorter than a mean solar day by 3m. 56s.; consequently the stars come to the meridian of any place nearly four minutes of time earlier on each succeeding day. Their revolution in the heavens may be taken as perfectly regular, since our distance from the stars is so inconceivably great that the earth's annual motion in space is quite imperceptible when compared with it. That is, the elliptical path of the earth around the sun becomes nearly a perfect circle at such distance. The stars are so far away from the earth that their distances cannot be measured in miles, but in light years, that is, the distance that light would travel in a year. The velocity of light is 186,337 miles per second. The mean distance of the sun from the earth is 93,000,000 miles, and it takes the sun's light 8m. 18s. to traverse this space, but to count 93 millions would require an unbroken period of nine months. This will convey some faint idea of how far away in space the nearest stars must be. The nearest distance expressed in words, is about 25 billions of miles, or 25,000,000,000 miles, represents it in figures. In the contemplation of these numbers the imagination is lost, for it means 25 millions of millions. Just think of a star situated from the earth 3 light years, which means that at the rate light travels it would take 3 light years for the light from this start to reach our earth. Think of it! If this is appalling to the mind what must be 200 light years for a star's light to reach the earth? Nevertheless, it is so. The north star has a light journey of only 42 years before its light is seen on the earth, which is equal to saying that should it disappear from some cause or other, its light would still be seen on the earth for 42 light years afterward. The star Sirius, the dog star, is only 8½ light years from us. At present, stars of the 18th magnitude constitute the seeing limit of the largest telescopes. It is calculated that light from some of the 17th magnitude stars takes probably 30,000 years to reach us. To give the student some idea of the magnitude (brightness) of stars let it be said that the north star (Polaris) has a magnitude of 2.2 and Sirius a magnitude of 1.4. It must not be understood that magnitude or brightness has anything to do with the distance that the star is situated from us in space. it is merely its brilliancy. Polaris, as we have already said, has a light journey of 42 years, but its near neighbor Kochab (in the outer rim of the Little Dipper), but with slightly less brilliancy, has a light journey of 148 years.

Revelations such as these give one some faint idea of the sublimity of the universe, and of the completely insignicant part played by our little earth —little compared with some of the stars mentioned. Take Sirius for example; its mass is about 2¼ times that of the sun. The diameter of the sun is 866,500 miles, and its surface is 12,000 and the volume 1,700,000 times that of the earth, but the mass is only 332,000 times as great, so that the density is only about one-quarter that of the earth. The sun weighs about 760 times as much as all the planets put together. The period of rotation is 25.3 days at the equator, 25 days at latitude 20°, 23 days at latitude 40°. The period of rotation of Sirius is about 58½ years. It is probably that each of the fixed stars is really a sun, and the center of a separate system of planets, but so far from us that the planets are invisible. Our sun is supposed to be in the center of the group of planets, called the solar system, which depend on the sun for their light. Some of these stars are apparently approaching the earth while others are receding from it at the slow velocity of 50 miles a second, and Procyon is approaching it at the rate of only 7 miles per second. Some stars are regarded as immeasurable in distance. Arcturus is another remarkable star, not only in point of brilliancy, but in size it very much resembles our own sun, though it is about 100 times greater in diameter than the sun, which means that it would just about fill the space between this earth and its primary.

We will now go back to the subject of time. The precise meaning of mean solar time and its average length, and the reason it is divided into 24 hours may be explained by the following simple example: Supposing an observer situated or seated, on the meridian of Greenwich with a Pelorus set to the true points of the horizon and the azimuth attachment set to true north and south, so that when the sun is on his meridian it can be detected by the instrument; he has a perfect time piece regulated to mean time; each day at the instant the sun crosses his meridian, as indicated by his Pelorus, he notes the time and sets it down. He keeps this up for one year, at the end of which time he adds together the exact time for each day that the sun is on his meridian, and this sum he divides by the number of days corresponding to the number of observations taken. His answer will be exactly 24 hours. Four days in the year he will find that the sun will be on the meridian at the precise time that the hour hand of his time piece shows 12 o'clock noon. At all other times the hand will indicate a little before or after noon when the sun is on his meridian. Sometimes the true solar day as compared with the time piece keeping imaginary time, will be more than 24 hours in length and other times will fall short of 24 hours; but

the varying lengths of the true day, when taken as a sum and divided as directed above, will give the exact average length to be 24 hours.

Now, let the observer take the bearing of a star when on his meridian, noting the exact time it takes to make two consecutive transits of his meridian by this same time piece. He then regulates a second time piece so that precisely from the time the star he is using, is on his meridian until it returns to his meridian, is exactly 24 hours. This then will be the length of a sidereal or star day, which is the true length of time that it takes the earth to make one complete rotation. Both these days are divided into the same number of hours, yet the length of the mean solar day is 3m. 56s. longer than the sidereal day. This seems a puzzling statement, and it would be to the navigator were he not provided with tables containing the necessary data for converting sun time into star time and the reverse.

If the observer at Greenwich, as in the above example, were to start his reckoning of the sun when on the meridian from April 15, of the year this was written (1904), he would find the sun on his meridian at precisely 12 o'clock by his mean time clock. From that time until May 24 the true sun would be ahead of the imaginary sun, so that when the former was on the meridian as shown by Pelorus, the mean time clock would show a little before 12 o'clock. On May 14 there would be 3m. 49s. difference in favor of the real sun, that is at 3m. 49s. to 12 by mean time the sun would be on the meridian and it would be true noon, or 12 o'clock apparent time. Remember that at the instant the sun is over the meridian of any place it is 12 o'clock apparent time at that place, or at the instant the sun bears true south (or true north, as the case might be) at any place it is true noon, or 12 o'clock apparent time at that place. From May 14 the mean time starts to catch up with the apparent time, until June 14, when they are right together again, which amounts to saying that the imaginary sun is exactly "in one" with the visible sun. According to this then, between the dates of April 16 and June 14, the equation of time must be subtracted from apparent time to find the mean time; or added to the mean time to obtain the apparent time. Thus, in the case of May 14 the equation of time is 3m. 49s. to be subtracted from apparent time or added to mean time. If on that date it were desired to know what time the sun would be on any meridian on which the observer happened to be situated, subtract this from 12 o'clock (the apparent time that the sun is directly over any one meridian) and the result is the mean time of the sun's transit. If on that date the sun were to set at 6h. 45m. apparent time, you know that the time by mean clock is 3m. 49s. less than it would be by apparent time. From June 14 to Aug. 31, mean noon is ahead of true noon, so that according to mean time the sun does not come to the meridian until the hour hand of the mean time clock is a little past 12. On July 26 they reach their greatest separation for that interval, being 6m. 18s. apart from each other. From this date to Aug. 31, they gradually come together, but with the mean time in advance, until on August 31, when the real and imaginary suns are as one. During this interval to obtain mean time from apparent time the equation of time would have to be added to apparent time, and to obtain apparent time from mean time the equation of time would have to be subtracted from mean time. From Aug. 31 the imaginary sun is again behind the real sun and remains thus until Nov. 3, at which time there are 16m. 21.4s. (the greatest possible amount of equation of time) difference in the two times. On the latter date the sun would be on your meridian at 16m. 21.4s. before 12 o'clock as shown by a well-regulated mean time clock. From Nov. 3 to Dec. 24 the two times gradually come together and are together on the latter date. From this date to April 15 the mean time is again in advance of the apparent time, and on Feb. 12 reaches its greatest separation for the interval, being 14m. 20s. From this date to April 15 they gradually come together, but mean time holds the lead until on this date they are again as one.

RECAPITULATION.

To recapitulate: The exact time when the sun is on the meridian of any place varies from day to day, because of the inclination of the earth's axis to the plane of its orbit, and because in some parts of its orbit, the earth travels faster than in others. If you have a clock keeping correct time, the sun and the clock will be together only four times in the year—on or about April 15, June 15, Aug. 31 and Dec. 31. From about Dec. 24 the sun is behind the clock, the difference becoming greater and greater until about Feb. 10, when noon by the sun is about 15 minutes later than by the mean time clock; then it gets less until the two agree on April 15. From this date until June 15, the sun is ahead of the clock. From June 15 to Aug. 31, the sun is slower than the clock. From then it gets ahead of the clock keeping mean time, until about Dec. 24. About Oct. 27 the sun is about 15 minutes ahead of the mean time o'clock.

The foregoing explanations ought to make clear the meaning of the terms apparent solar day (apparent time), mean solar day (mean time), and sidereal day (sidereal time).

SIDEREAL CLOCKS.

Astronomical clocks, regulated to sidereal time, are called sidereal clocks. In observatories, it is also customary to have an additional clock regulated to sidereal time, on account of the greater convenience in connection with certain of the astromomical observations. The face of this clock is numbered up to 24 hours so that the short hand makes but one round of the circle in that time. If the faces, or dial plates, of all clocks were thus represented it would be of the greatest convenience, and would save many mistakes in astronomical navigation, at least, if not in other ways.

As the sidereal day is 3m. 56s. shorter than the mean solar day, 365¼ days, or a year, equal 366¼ sidereal days. The sidereal and mean solar days are both invariable. Both are divided into 24 hours. The sidereal hours are counted from 0 to 24, commencing with the instant of the passage of the true vernal equinox over the upper meridian, and ending with its return to the same meridian. About March 21 of each year the sidereal clock agrees with the mean time, or ordinary clock, and the former gains on the latter about 3m. 56s. per day, so that at the end of a year it will have gained an entire day, and will again agree with the mean time clock.

It must not be understood that there are only 23h. 56m. 4s. to a sidereal day, and that this length of time represents the actual time it takes the earth to make one absolute rotation.

It must be remembered that every kind of time is divided into the same number of hours, namely, 24. The time of two consecutive transits of the true sun over the same meridian, although variable, is divided into 24 equal parts, or hours. Machinery cannot be constructed to keep time with this variability, and so an imaginary sun, one that travels uniformly the year round, is made use of and its length is based upon the mean length of all the apparent solar days in the year; this conforms to 24 hours.

A clock regulated to keep mean time is made to run uniformly, and keeps pace, as it were, precisely with the mean sun, so that when the mean sun is on the meridian of any place, the clock set to the mean time of that meridian, indicates 12 o'clock; and 24 hours thereafter, the sun is again on the meridian, and so on throughout every day in the year. A clock regulated to mean time, and accurately run, really represents the mean sun, for any time that it be required to know over which meridian the sun is crossing all that is necessary is to turn the number of hours and minutes that have elapsed from your noon into longitude of arc and apply it to your meridian of longitude according to the rules already laid down. Remember that this means mean sun; to true sun you would have to apply the equation or time.

The sidereal day, like the mean and apparent day, is divided into 24 equal parts or hours, but in this case the time is absolute and not relative as in the other cases. As the earth rotates on its axis at a uniform rate of speed throughout the year, a clock can easily be regulated to keep time to its movements, but its measure must not be taken from the sun, because of the un-uniformity of the earth's revolution in its orbit. This, as we have seen, is called sidereal time, or star time; so-called from the fact that it depends on the stars for measurement, the same as solar time depends on the sun for its measurement.

The stars are at such inconceivable distances from the earth that the obliquity of the ecliptic and the eccentricity of the earth's orbit become small and negligible quantities. This being the case, the time that it takes any star to return to the same meridian on successive nights must measure one complete rotation of the earth on its axis. A clock regulated to sidereal time would show the same star on the same meridian at precisely the same time every night (or day). But to time this star when it comes to your meridian by the mean solar clock you would find that the star culminated each night about 4 minutes earlier. Why is this? The mean solar clock merely measures the time of the mean sun and has no connection whatever with any scale of nature, but is made to coincide with the speed of this imaginary sun, which is the mean of its true rate of speed, but this sun is not made to mark the time of a complete rotation of the earth on its axis. In fact the earth has completed one absolute rotation, and has a start of nearly 4 minutes of time on the next rotation in the 24 hours as shown by a mean time clock, and that is the reason that the sidereal day is nearly 4 minutes shorter than the mean day, or when the mean time clock has reeled off 24 hours the sidereal clock will have run 24h. 4m. This likewise accounts for the stars coming to the meridian about 4 minutes earlier each night according to mean time.

The beginning of the sidereal day does not, therefore, correspond to a definite fixed hour of solar mean time, but in the course of a year runs through all the hours of the ordinary day by which the affairs of life are regulated. A sidereal clock, therefore, would not run with a mean time clock; supposing both to be started at the same instant, the sidereal clock would soon outstrip, or lead the other. They would agree only once in the year. To test this roughly, multiply 365 by 4, and the product will be approximately 24 hours. Hence, 366 sidereal days are equal to 365 mean solar days. For confirmation of this, look in the nautical almanac for March, and you will find that the sun's right ascension is 0h. 0m. 0s. when on the equator (spring equinox; or at the time the sun crosses the line bound north). The "sidereal time," in the last column of page 2 for the month would also be 0h. 0m. 0s. were it not given for mean time. Thence onward, month by month, it steadily increases, until in September, when the sun is again crossing the line, but this time in the opposite direction, the "sidereal time," has grown to 12 hours, and continues to grow till it has attained the maximum of 24 hours in the following March.

The consequence is that those stars which are now rising in the east, at any given hour of solar mean time, will be found setting in the west at the same hour six months hence; while those which at any hour are now setting, will, at the same hour six months hence, be found rising. This, of course, applies to any part of the year, and six months before or after it.

It so happens that the right ascension of the meridian and the local sidereal time are the same thing. Right ascension means celestial or astronomical longitude, as opposed to terrestrial or geographical longitude. As we have seen, the sidereal day contains 24 hours, but it does not begin at midnight as the legal day does, nor at noon like the astronomical day. It begins when the prime celestial meridian (that at which celestial longitude commences) is right over the meridian on which you stand. It is, then, what you might call sidereal noon at your place, just as it is solar noon when the sun is on the meridian.

In the thoughtful mind the question may be raised as to whether longitude when measured by an interval of sidereal time, is the same as when measured (numerically speaking) by a similar interval of mean time, seeing that sidereal and mean time have different absolute values. Raper disposes of this question thus:

"The difference of longitude is found as well by means of the motion of a star as of the sun; that is, by means of a clock regulated to sidereal time, as well as one regulated to mean time. For although the absolute interval of time employed by a star in moving from one meridian to the other is less than that employed by the sun, yet it is divided into the same number of hours, minutes and seconds, but which are of smaller magnitude, and thus the difference of time results, in numbers, the same."

In connection with time, there is one point which deserves more than a passing notice; and which one who is not familiar with the subject finds it difficult to realize, and that is, that at the same moment that there should be a difference of time at various parts of the earth's surface—nor is this really the case so far as absolute time is concerned. The present moment here in the United States is equally the present moment in the Philippine Islands, although the clock there marks some 10 hours later than it does with us. This is accounted for by the fact that the sun, which is the divider of day and night, and all over the world the recognized marker of time, crosses the meridian of the Philippines some 10 hours before it reaches ours.

In the daily course of the sun, his advent at each meridian on the earth's surface marks the hour of noon for all places on that meridian. It is thus that the sailor, more especially, reckons his time. No matter what seas he may be navigating, he considers it noon the moment the sun is meridian high.

In turning these various definitions over in the mind, one must try not to get "mixed", as will, however, very likely be the case with those whose attention has only been seriously called to them for the first time. Do

not be disheartened and tempted to skip back, as each fresh reading will give more insight, until the whole is plain as A B C.

Time is an essential element in navigation, and entering as it does in all of the astronomical problems, it is as necessary to be understood as the points of the compass.

DAY.

The *Civil Day*, according to the customs of society, commences at midnight, and comprises 24 hours, from one midnight to the next following. The hours are counted from 0 to 12 from midnight to noon, after which they are again reckoned from 0 to 12 from noon to midnight. Thus the day is divided into two periods of 12 hours each, of which the first is marked A. M., and the last is marked P. M.

The *Astronomical Day* begins at noon on the civil day of the same date. It also comprises 24 hours, but they are reckoned from 0 to 24, and from the noon of one day to that of the next following. The astronomical as well as civil time may be either apparent or mean, according as it is reckoned from apparent noon or mean noon.

The civil day begins 12 hours before the astronomical day; therefore, the first period of the civil day answers to the last part of the preceding astronomical day, and the last period of the civil day corresponds to the first part of the same astronomical day. Thus, Jan. 9, 2 o'clock A. M., civil time, is Jan. 8, 14h. astronomical time; and Jan. 9, 2 o'clock P. M., civil time, is also Jan. 9, 2h. astronomical time. The rule, then, for the transformation of civil time into astronomical time is this: If the civil time is marked A. M., take one from the date and add 12 to the hours, and the result is the astronomical time wanted. If the civil time is marked P. M., take away the designation P. M., and the astronomical time is had without further change.

To change astronomical to civil time, we simply write P. M. after it, if it is less than 12 hours. If greater than 12 hours, we subtract 12 hours from it, add 1 to the days, and write A. M. For example, Jan. 3, 23 hours, astronomical time, is Jan. 4, 11 o'clock A. M., civil time.

If the longitude from Greenwich be expressed in time, and when west, added to the local time, or when east, subtracted from the local time, the result is the corresponding Greenwich mean time. If the local mean time is used, the result is the Greenwich mean time, which ordinarily is that required for the use of the Nautical Almanac. The rule is the same, whether we use mean or sidereal time.

THE ASTRONOMICAL, OR NAVIGATORS' DAY.

This is the mean solar day that begins at noon on the first standard meridian, that of Greenwich. A ship's chronometer shows Greenwich time, and thus enables a navigator to know his exact longitude on the ocean from day to day. This is the same as spreading the local time of Greenwich, not over an hour-belt, but all over the world.

It must not be understood from this that the chronometer shows the longitude by the number of hours that have elapsed at Greenwich. It first becomes necessary to find the time at ship by a "time sight" and the diffence between this and the Greenwich time, as shown by the chronometer, is the actual number of hours the ship is from Greenwich. This time is to be converted into arc.

It must not be forgotten that longitude is reckoned in time as well as in arc.

THE LOCAL CIVIL DAY.

This is the mean solar day of 24 hours which begins at midnight. It is the day that is dated in the calendar. The change of date occurs first at an irregular line (International Date Line) passing from pole to pole through the Pacific ocean.

LOCAL TIME.

Since the earth turns on its axis from west to east, the sun will come to the several meridians of our western cities after it has already passed those of the eastern ones. Since the whole revolution through 360 degrees is performed in 24 hours, a change of 15 degrees of longitude changes the time one hour. The same moment that it is 9 o'clock at Memphis (00° W.) it is 10 o'clock in Philadelphia (75° W.) and 8 o'clock in Denver (105° W.). The mean solar time shown at a given place is called local time, and has until 1883 been in universal use. All places having the same longitude must have the same local time.

STANDARD TIME.

Primarily, for the convenience of the railroads, a standard time was established by mutual agreement in 1883, by which trains are run and local time regulated. According to this system the United States, extending from 65° to 125°, west longitude, is divided into four time sections, each 15° of longitude, exactly equivalent to one hour. The first (eastern) section includes all territory between the Atlantic coast and an irregular line drawn through the center of Lake Huron, thence to Detroit and across Lake Erie to Conneaut. From Conneaut in an irregular line to Charleston, S. C. The second (central) section includes all the territory between the last-named line and an irregular line from Bismarck, N. Dak., to the Rio Grande. The third (mountain) section includes all territory between the last-named line and nearly the western borders of Idaho, Utah and Arizona. The fourth (Pacific) section covers the rest of the country to the Pacific coast. Standard time is uniform inside each of these sections, and the time of each section differs from that next to it by exactly one hour. Thus at 12 noon in New York City (eastern time), the time at Chicago (central time) is 11 o'clock A. M.; at Denver (mountain time), 10 o'clock A. M., and at San Francisco (Pacific time), 9 o'clock A. M. Standard time is 16 minutes slower at Boston than true local time, 4 minutes at New York, 8 minutes faster at Washington, 10 minutes faster at Charleston, 28 minutes slower at Detroit, 18 minutes faster at Kansas City, 10 minutes slower at Chicago, 1 minute faster at St. Louis, 28 minutes faster at Salt Lake City, and 10 minutes faster at San Francisco.

THE OBJECTS FOR SUCH A SYSTEM.

Local time sufficed for all social purposes until 1883. The introduction, multiplication, and interlacing of railroads soon led to difficulties and dangers arising from the use of local time. Safety and system require that every railroad must have a carefully constructed time-table to regulate the running of its trains. The time shown in the table was the local time of some important place on the road, usually one of its termini. The watch of every conductor and other employe on that road must show the local time of this termini. This time necessarily differed from the local time of all other places on that road. On long roads the difference was sometimes more than an hour. It thus happened that trains running through the same railroad center from various termini had three or four, and sometimes even a greater number of different standards of time. These considerations led, by general agreement, to the adoption, in 1883, of the following system of time for the railroads of the United States and Canada. It is based upon the system of local time already explained.

STANDARD MERIDIANS.

Meridians 75°, 90°, 105°, and 120°, west of Greenwich are selected as standard meridians. They are 15° apart. The local time on any one of them, therefore, differs exactly one

hour from the local time on either of the two others between which it is situated.

HOUR-BELTS.

Each standard meridian is the middle line of a belt 15° wide, extending 7½° east and 7½° west of that standard meridian.

BELT TIME.

Whatever may be the local time at a given instant on any standard meridian, that is taken to be the time at every place in the belt through which that meridian runs. That is, if it is 10 minutes of 5 local time on the standard meridian, every watch in every place in that belt should at the same instant show 10 minutes of 5.

AGREEMENT.

Since the standard meridians are 15°, or exactly one hour apart, if it is 10 minutes of 5 in one belt it is 10 minutes of 4 all over the belt next west of it, and 10 minutes of 6 all over the belt next east of it. Therefore whatever be the place of the hour hands, the minute hands of all watches in the United States and Canada will point to the same figure.

TERMS USED.

The time shown in the belt of the seventy-fifth meridian is known as Eastern Time; in that of the ninetieth meridian as Central Time; in that of the 105th meridian as Mountain Time; and in that of the 120th meridian as Pacific Time. The sixtieth meridian, proposed as Inter-colonial Time, is not yet in use.

ADOPTION.

Many great cities lie quite near some standard meridian. This promptly led to a wide adoption of the new standard time for all social purposes, the change at New York being less than 4 minutes, and at Philadelphia and St. Louis only about 1 minute. But places on or near the borders of the hour-belts required a change of about 30 minutes. Besides this, some of the long railroads have been obliged to push the time of a terminus lying in one belt far over into an adjoining belt. This has caused the lines separating the belts to be very irregular, and the belts to vary greatly in width, thus departing from the simplicity of the original plan. The standard time at Bismarck, Dak., is 43 minutes earlier, and that at Erie, Pa., is 40 minutes later than the local time; so that the new standard noon at the former place sometimes comes 58 minutes before, and at the latter place 55 minutes after, the sun crosses the meridian. For these and other reasons, among which is the fact that many occupations are practically dependent upon the sun's light, many cities, and some large districts of country, have not yet adopted the new standard of time for general social purposes.

EXAMPLES.

Chicago is in the central time belt, and her clocks are set to ninetieth meridian time, which signifies that if these clocks were taken to the ninetieth degree of longitude from Greenwich, they would show the mean time of the sun for that meridian. As Chicago is situated several degrees to the eastward of the ninetieth meridian, the time as shown by her clocks is slow of mean sun time by the amount of difference of longitude between the meridian passing through that city and the ninetieth meridian converted into time; thus:

Meridian central standard time is based up	90° 00′ 00″ W
The meridian passing through Chicago	87° 37′ 45″ W
Difference of longitude	2° 22′ 15″
To convert into time multiply by	4
Difference between standard and mean time for Chicago	9′ 31″

Supposing at Chicago it is desired to know what the mean time is when the standard clock shows 9:30 A. M. As Chicago is to the eastward of the ninetieth meridian (the meridian of central time) the standard time must be slow of Chicago's mean time, for the sun comes to her meridian before it does to the ninetieth meridian, 9m. 31s. earlier; consequently we add this difference of time to the standard time to obtain the corresponding mean time. When it is 9:30 at Chicago by standard time it is 9:39:31 by mean sun time.

From this we derive the following rules:

When a place lies to the eastward of the meridian upon which its standard time is based its difference of longitude converted into time should be added to the standard time to obtain the corresponding mean time.

When a place lies to the westward of the meridian upon which the standard time is based, this difference in longitude converted into time should be subtracted from the standard time to obtain the corresponding mean time.

Example: Duluth is in longitude 92° 05′ W., and her standard time is based upon the ninetieth meridian, or central time belt. The time shown by her clocks is fast of the mean sun time for that port, as she lies to the westward of the meridian from which her time is figured; or the sun crosses the ninetieth meridian before it does her meridian.

Meridian central standard time is based upon	90° 00′ 00″ W.
The meridian passing through Duluth	92° 05′ 00″ W.
Difference of longitude	2° 5′
To convert into time multiply by	4
Difference between standard and meridian time for Duluth	8′ 20″

The mean time is that much slower than the standard time for that port. Hence, when Duluth clocks show 9:30 A. M. the mean time is 8m. 20s. less, or 9:21:40.

Buffalo standard time is based upon the seventy-fifth meridian, or eastern standard time, because it lies nearest this time section. As Buffalo is in longitude 78° 54′ W., the time as shown by her clocks indicating standard time is fast of the mean sun time, by the amount of difference in the two longitudes converted into time.

Meridian of Buffalo	78° 54′ W.
Meridian of eastern standard time	75° 00′ W.
Difference of longitude	3° 54′
	× 4
Fast on mean time	15′ 36″

When the standard clocks of Buffalo show 9 A. M., it is 15m. 36s. less for mean sun time. When the clocks are striking 12 noon, the mean sun time is 11h. 44m. 24s., because the time as shown by standard clocks is for the mean time of the seventy-fifth meridian, and as Buffalo is to the westward of this meridian this time is fast of her mean sun time, and consequently must be subtracted from the time as shown by clocks keeping standard time.

Cleveland is situated in the central time belt and her clocks are set to the mean time of the ninetieth meridian, or which amounts to the same thing. Cleveland is located on the meridian of 81° 43′ west of Greenwich, and its standard time as shown by her clocks is 33m. 8s. slow of the mean sun time for her meridian, that is, the sun comes to her meridian 33m. 8s. sooner than is shown by her clocks; therefore, to obtain the mean sun time at Cleveland we must add 33m. 8s. to the time as shown by her clocks, or which in reality is the mean time for the ninetieth meridian, and

only agrees with the mean sun time on that meridian.

At Cleveland what time will the sun be on the meridian (bearing true south—true or apparent noon) according to her standard clocks, the date being June 1, 1904, that is, when the sun is exactly on the meridian how had these standard clocks ought to read?

It is presumed that the student has a copy of the Nautical Almanac for that year. Remember that when the sun, at any time of the year, is over or on the meridian of the observer, it is 12 o'clock apparent time, or the true sun's time is 12 o'clock.

This is an important consideration in azimuth work, as you will presently see. The first thing to be done in the above example is to pick out the equation of time from the almanac that will agree for the date, June 1. As the example is changing apparent time to mean time we take the equation of time out from page I (remember, always the left hand page when dealing with apparent time, and the right hand page—II—when dealing with mean time). The precept at the top of the equation column says "Equation of Time to be Subtracted from Apparent Time"; hence, the equation of time for June 1 is 2m. 27s. subtractive, or thus:

The apparent time that the sun is on the meridian of any place is true noon at that place, and the time is.......	12h. 00m. 00s.
Equation of time for June 1, sub. from app. time	2m. 27s.
Mean time that the sun is on the meridian.....	11h. 57m. 37s.
Correction for diff. long. between Cleveland and the ninetieth meridian on which her standard time is based, 8° 17', or	33m. 8s.
The time that the sun is on the meridian of Cleveland according to her standard time, which is equal to mean sun time on the ninetieth meridian	11h. 24m. 25s.

Note.—We subtract the correction for longitude converted into time from mean time because apparent time is that much earlier, Cleveland being to the eastward of the ninetieth meridian of longitude, or, in other words, the sun comes to the meridian of Cleveland that much earlier than it does on the ninetieth meridian.

The apparent time of sun rise at Cleveland on June 1, 1904, is 4h. 31m. 30s., what is the corresponding standard time of sun rise, that is, what time should a watch set to the standard meridian of 90° indicate at the time the sun was on the horizon of the lake for the above date?

Apparent time of sunrise.	4h. 31m. 30s.
Equation of time, subtract	2m. 27s.
Mean time of sunrise....	4h. 29m. 03s.
Correction for long., sub.	33m. 8s.
Standard time of sunrise.	3h. 55m. 55s.

It must be borne in mind that the time data contained in tables giving the time of sun rise and sun set is for apparent time and to obtain its corresponding standard time, must be reduced as above, before it can be practically applied.

In problems of this kind when it is desired to change apparent time to standard time, observe the following proceedings: With your date enter the nautical almanac with the month and year at the top, seeking in the left hand page (I) ninth column, with "Equation of Time" at the head, pick out the equation of time, noting its precept at the top whether it says "to be added to apparent time" or "to subtract from apparent time." Apply this equation of time to your apparent time according to the rule. Next find the longitude from the chart, or lighthouse book, for your position, and if your watch is set to ninetieth meridian (central time, or seventy-fifth meridian—eastern) time, find the difference in longitude between it and the meridian for your position. Convert this difference into time, and call it "Correction for Longitude." Then, if you are to the eastward of the meridian upon which your time is based, subtract this correction for longitude from apparent time to get mean time; and if you are to the westward, add it to your apparent time to get mean time.

Example: It is June 1, again, supposing you are off Pt. Betsey, in Long. 86° 20' W., your watch shows central standard time, and you desire to know at what time by your watch the sun will be on your meridian; you want to try your compass on south for deviation, say. Form:

Apparent time	12h. 00m. 00s.
Equation of time, sub...	2m. 27s.
Mean time	11h. 57m. 33s.
Correction for long. 3° 40'	14m. 40s.
Standard time sun on the meridian	11h. 42m. 53s.

Hence, when your watch shows 11:42:53 (in practice we would discard the seconds, in this case we would call 53s. one minute) the sun will be on your meridian, bearing true south from you, and it is then true noon, or 12 o'clock true time. The variation at Pt. Betsey is equal to about ⅛ pt. Ely., which apply to the left of the sun's true bearing south, making the correct magnetic bearing S ⅛ E (in the same manner that you would correct a true course for variation to obtain the correct magnetic course). Head your boat right for the sun, and when steady, the difference between what your compass reads and what you know the sun's correct magnetic bearing to be, is the deviation, and is named Ely, if the sun's correct magnetic bearing is to the right of the compass pearing, and Wly if to the left; that is, supposing the compass reads S by E at the time, the Dev. will be ⅞ pt. Ely; if the compass reads S ½ W, the Dev. will be ⅝ pt. Wly. Do you see it? Should you ever have occasion to try this head your boat for the sun several minutes before the time of the sun's meridian crossing, and follow the sun by conning the ship's head as the sun goes round, so as to do away with the effects of retained magnetism, and to give the magnetism in the vessel a chance to settle down to a permanent state for the changed direction of the ship's head.

Supposing you go to Buffalo from Chicago; your watch is set to ninetieth meridian time (the same as shown by the clocks of Chicago). Off Buffalo harbor, before entering, you desire to get the bearing of the sun at setting. You look in the azimuth tables according to your latitude and the declination of the sun for the day of the month, and you find, for example, say, that the sun sets at 6h 35m. apparent time, and the equation of time as found from the nautical almanac for your date say is 6m. 40s. addative, and your longitude is 78° 58' W.

Apparent time	6h. 36m. 00s.
Equation of time (add).	6m. 40s.
Mean time	6h. 41m. 40s.
Corr. for long. (11° 2') sub.	44m. 8s.
Ninetieth or C. S. time of sunset	5h. 57m. 32s.

(To be continued.)

Daylight trips between Detroit and Cleveland will begin June 30.

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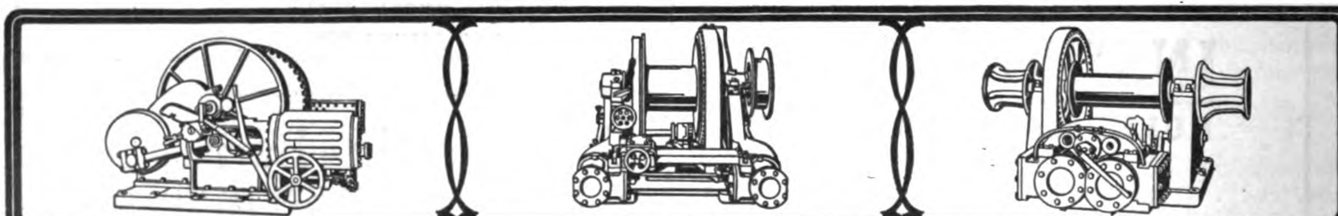

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PROPOSAL

U. S. Engineer Office, Milwaukee, Wis., June 5, 1908. Sealed proposals for building plank crib revetment, removing old pier, and dredging at Manistique Harbor, Mich., will be received here until 2 P. M., June 22, 1908, and then publicly opened. Information on application. W. V. Judson, Major Engrs.

U. S. Engineer Office, Duluth, Minn., June 10, 1908. Sealed proposals for dredging in Duluth-Superior harbor will be received here until noon, June 30. 1908, and then publicly opened. Information on application. Graham D. Fitch, Major, Engrs.

TREASURY DEPARTMENT,
Washington, D. C., June 9, 1908.

SEALED PROPOSALS are invited and will be received at the Division of Revenue-Cutter Service, Treasury Department, at 2 o'clock p. m., Saturday, June 27, 1908, for the purchase of the Revenue Cutter DALLAS.

The DALLAS is a single screw steamer of 370 tons displacement, with a wooden hull; extreme length 140 feet, beam molded 21 feet 5 inches, draught 10 feet 9 inches; has one Scotch boiler 11 feet in diameter by 12 feet 6 inches in length, fitted with steam drum and three furnaces and operating 35 pounds pressure. The main engine is of the simple, condensing type, with a cylinder 34½ inches diameter by 30 inches stroke, and is capable of 75 revolutions per minute; one surface condenser, with independent centrifugal circulator, with air and feed pumps of the attached type. The vessel is supplied with one general service or fire pump, a steam bilge ejector and one boiler injector.

The DALLAS is at Ogdensburg, N. Y., and can be seen at that place on application to Senior Captain H. D. Smith, U. S. R. C. S., who will furnish any additional information regarding it that may be desired and a list of articles of outfit that are to be sold with the vessel.

Each bid must be accompanied with a certified check in the sum of $500, made payable to the order of the Secretary of the Treasury. The Government reserves the right to reject any or all bids.

Proposals should be addressed to the Secretary of the Treasury and indorsed on the envelopes "Proposals for the purchase of the Revenue Cutter DALLAS."

(Signed) BEEKMAN WINTHROP,
Assistant Secretary.

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